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PULMONARY TUBERCULOSIS

ITS ETIOLOGY AND TREATMENT

A BRIEF SURVEY OF THE SCIENTIFIC, THE SANATORIUM AND THE SOCIAL ASPECT OF TUBERCULOSIS

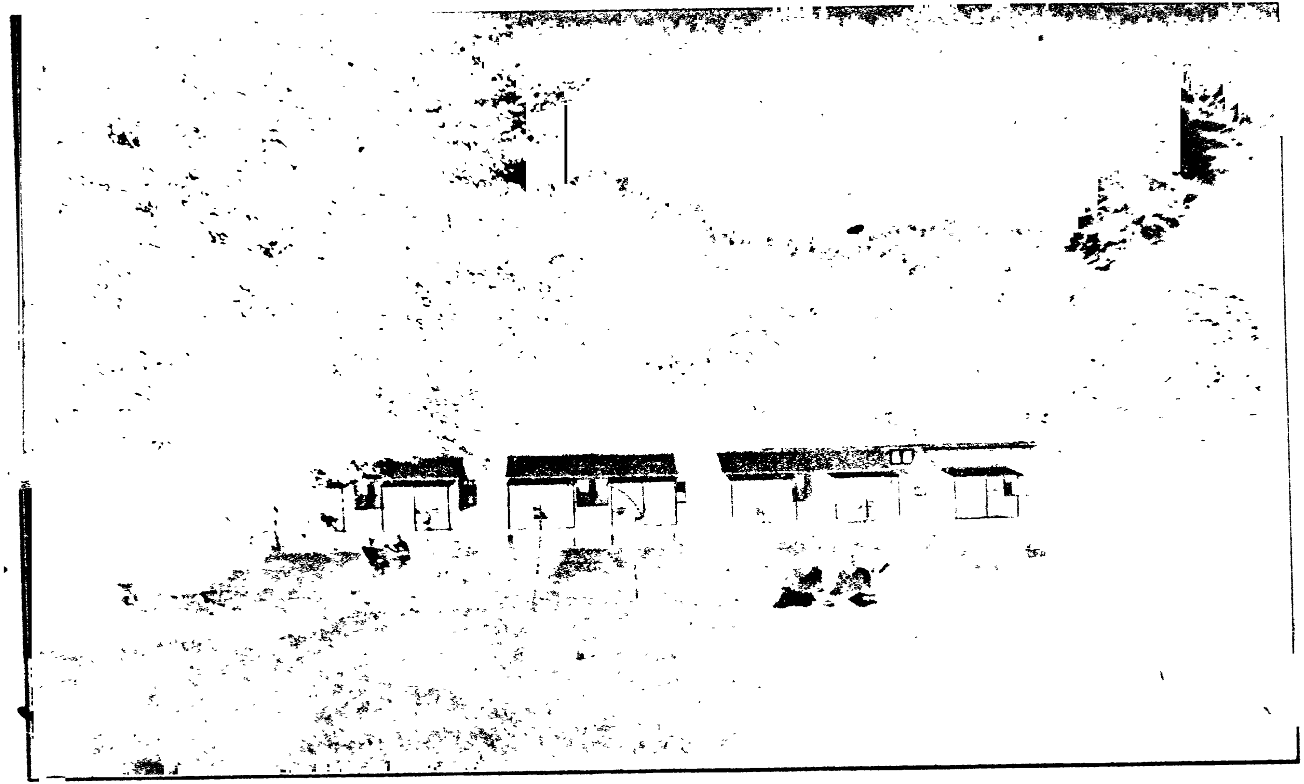

FIG. I.—GROUP OF CHÂLETS AT MENDIP HILLS SANATORIUM.

Frontispiece.

PULMONARY TUBERCULOSIS

ITS ETIOLOGY AND TREATMENT

A RECORD OF TWENTY-SEVEN YEARS' OBSERVATION AND WORK IN OPEN-AIR SANATORIA

BY

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'PULMONARY TUBERCULOSIS AND SANATORIUM TREATMENT'
'A SHORT ACCOUNT OF THE ANTIQUITY OF HINDU MEDICINE,' ETC.

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"The strength of a character is measured by its resistance to the contagion of accepted ideas."

MOORHOUSE: *Quarterly Review.*

PRINTED IN GREAT BRITAIN

PREFACE TO THE SECOND EDITION

In this new edition the scheme of the book remains the same, and the author does not find it necessary to alter any of the main conclusions and views that have been put forward in the body of the work. In fact, the principles laid down in the previous edition are given in the present a greater emphasis and wider outlook. A chapter on the general survey of tuberculosis has been added which summarizes the present state of our knowledge of the disease. In reviewing the whole problem of tuberculosis from its preventive aspect and in its broad relation to the health and well-being of man, there present themselves two or three important ways along which medicine may advance in the future.

(*a*) The trend of modern thought points more than ever to the betterment of the social and economic conditions of the people for the real solution of prevention of tuberculosis. The growing desire of the community for the fresh-air life and for improvement in their environmental conditions, together with the endeavour of civilized nations to carry out a programme of social welfare and health service, give promise of producing a stronger and more efficient race in the coming generation which will result in the gradual reduction of the incidence and mortality of tuberculosis.

(*b*) The recent progress made in non-specific therapy has enabled us to recognize Nature's vital activities in the cure and arrest of disease through inflammatory reaction rather than through any specific means. To understand and follow Nature's methods (Nature is only another name for the Divine power) is to realize the ways and means to secure the elimination of tuberculosis.

(*c*) The discovery of the electronic concept of matter and of its property of radio-activity when applied to the human body opens up great possibilities in the conquest of disease. As Marconi says, 'We are just entering what may be called the field of vibrations, a field in which we may find more wonders than the mind can now conceive.' The practical application of electro-magnetic waves and their various frequencies in the realm of commerce can surely be extended to medicine for the detection and prevention of disease, if the medical profession has the courage and insight to make use of them for the good of suffering humanity. Unless the campaign against tuberculosis teaches the civilized man to change his present material, strenuous and unhealthy aims and pursuits, and to follow a more sane, simple, and natural living, he will have gained no advantage even if he had achieved the conquest of consumption, as by escaping from tuberculosis he will only fall a prey to a brood of other evils, such as cardiac, renal, and malignant diseases that lurk within civilized beings.

Prevention is the order of the day. The freedom that is worth having is freedom from disease. Therefore it is becoming more and more necessary for medicine to understand the signs of the times, to welcome light from every quarter without bias or prejudice, and to lead mankind in the pursuit of preservation of health and the prevention of disease rather than spend its energy in the treatment of symptoms when disease is firmly established in the human body.

D. C. M.

LONDON,
September, 1927.

PREFACE TO THE FIRST EDITION

In this volume the writer approaches the problems of tuberculosis from the nutritional and other aspects, which were dimly outlined in his previous work, and which are now amplified and enlarged by the survey of recent advances in scientific knowledge. Since my previous work on the subject was written in 1910, we have travelled a long way on the path of research and experience in tuberculosis. We have lingered long enough at the milestone of bacteriology. We are now tempted to stop at biochemistry, and to make much of the marvellous revelations of chemical and biological actions within the human body. Further on the way sociology meets us to show how profoundly normal and abnormal processes are influenced by man's daily life and environment, and psychology beckons us to explore the untrodden paths of human thought and action in their bearing on health and disease. In the growing light of these sciences we can no longer be satisfied with microbe and other theories which did duty a generation ago. The spirit of the times demands that we should adjust our angle of vision and study life's processes from social, economic, and psychological aspects which offer a more satisfactory solution in the etiology and treatment of tuberculosis. If in the attempt to apply the message of modern thought to the many phases of tuberculosis there has been some criticism of orthodox views, it is to emphasize that health and disease have physical as well as psychic and spiritual values, and that only in their right relation and perspective can a true picture of the disease be formed and its treatment satisfactorily carried

out. The reader may not be able to follow us all the way, but we shall be amply rewarded if his perusal of this work helps in any small way to stimulate thought, challenge enquiry, and broaden his horizon in the study of tuberculosis and other problems of life.

As in the previous work, the first part of this volume deals with the scientific, the second part with the sanatorium, and the third part with the social aspect of tuberculosis. Our sincere thanks are due to Professor Gowland Hopkins for valuable suggestions in the chapter in 'Biochemistry,' and to Dr. R. C. Macfie for his help in going over the proofs.

D. C. M.

October, 1922.

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A GENERAL SURVEY OF THE PRESENT-DAY PROBLEMS OF TUBERCULOSIS

'Knowledge grows, but wisdom lingers.'

The problem of tuberculosis and its prevention stands as one of the greatest and most pressing questions of the day in every civilized community. Since the issue of the last edition of this work a great volume of literature has been written on tuberculosis, and a vast amount of experimental and clinical work has been carried on in many parts of the world. But in spite of all the advance made in the knowledge of the disease, there are many problems still remaining obscure and requiring more light and investigation. We are not finally agreed on such elementary questions as to how the disease comes to exist in the body, or the common portal of entry into those who develop tuberculosis, or the relation between the primary infection in early childhood and clinical tuberculosis in adults. The views expressed by Kuss, Albrecht, and Ghon, on the primary occurrence of tuberculous foci in the lungs of children, are in strong contrast with Calmette's theory of primary infection through the alimentary canal. Instead of the dust, droplet, or milk infection, Krause thinks that much childhood infection is acquired through raw sputum from obscure cases of tuberculosis. While Bezançon, Marfan, Roemer, Hamburger, Ranke, Fishberg, and Baldwin[1] believe that adult tuberculosis is the result of lighting up a latent bacillary focus which has existed since childhood (endogenous infection), Sergent, de Krux, Aschoff, Reich, Hayek, Beitzke,[2] etc., assert that it is caused by a fresh exposure to infection from without (exogenous infection).

When we come to enquire into such deeper questions as to the part played by heredity and environment in the causation of tuberculosis, the mechanism of tuberculous

infection, the nature of tuberculin, the chemistry of immunity reactions, the source of resistance in the body, the origin and composition of antibodies and other anti-bactericidal substances, the relation between specific and non-specific therapy, or between allergy and immunity, etc., we find ourselves confronted with still more difficulties and differences of opinion. The truth is, the whole question of the tuberculosis problem is not so simple as some appear to think. It is extremely complicated with bacteriological, biochemical, psychological, endocrine, environmental, and sociological factors. Bacteriology alone has not succeeded in solving any of the problems. In fact, as one attempts to review the growing mass of literature on tuberculosis, one finds that the experimental work is marked by a conflict of views and divergent results from expert workers. The hypotheses and conclusions laid down by the older observers have been either modified considerably or discarded altogether by their successors, and so this constant change of opinion by experienced men leaves us in doubt and dilemma on many problems connected with tuberculosis.

The study of tuberculosis can be briefly reviewed under four headings: (1) Statistical; (2) Experimental; (3) Clinical; (4) Environmental or Sociological.

1. Statistical Aspect.

We should recognize at the very outset that conclusions drawn from a study of statistical calculations are very misleading, and cannot be relied upon without great reservation. For instance, the oft-quoted Brownlee's observation that the distribution of tuberculosis in early manhood and old age on the one hand, and in childhood and middle age on the other, is due to two different strains of tubercle bacilli. This statistical postulate is not proved by the present bacteriological evidence. Tulloch, Munro, Ross, and Cumming,[3] after an extended investigation involving the isolation and testing against an active immune serum of a hundred strains of tubercle bacilli, found that there was no antigenic difference between human tubercle bacilli, and no definite existence of

type or group. Also the statistics that are quoted to prove infection or immunity, or the extent of tuberculosis or its decline, are not free from fallacies. While from statistical studies, Pearson and Pearl consider that heredity is an adverse factor, Drolet concludes that it is rather an advantage in tuberculosis.

Again, post-mortem statistics cannot be relied upon to show the extent of tuberculosis among a given population. Tuberculosis is really a widespread affection among civilized people which does not culminate into a definite disease with definite symptoms in many thousands of cases. Therefore no statistics taken either from post-mortem or clinical examination, or even from a naked-eye appearance of tuberculosis, can give any idea of the wide prevalence of the disease. As Todd[4] found, the degree of tuberculization of the population must very considerably exceed the percentage of tuberculous lesions found on post-mortem examination. Further, post-mortem statistics giving the incidence of tuberculosis vary from Reinhart's 96 per cent., Naegeli's 98 per cent. of adult cases, Opie's 100 per cent. among the industrial population of St. Louise, to Kingston Fowler's 9 per cent., and Sidney Martin's 9·7 per cent. found in post-mortems at the Middlesex Hospital, London. This wide variation, for one reason, is due to the fact that the observers are not agreed as to what constitutes post-mortem signs of tuberculosis. Even calcification is now found not to be a special feature of tuberculous tissues, as any necrotic or devitalized tissue like cancer may become impregnated with calcium salts. While Opie thinks that calcification of nodes signifies a previous tuberculous infection, the special investigation committee appointed by the National Tuberculosis Association, America, found that calcified nodes at the root of the lung without evidence of lung disease is of no significance except as evidence of some healed inflammatory condition not necessarily tuberculous, and they are a common finding in normal chests.[5]

Besides, the figures for statistical purposes are often taken from the poorer classes attending public hospitals, tuber-

culosis dispensaries, or out-patient clinics situated in the cities. To get at some approximate truth, the survey should include all grades of society—the poor, the middle, and upper classes—living under various conditions and occupations, and the observation should be made on a very large number of persons and extending over a number of years.

Moreover, there is a fundamental fallacy in applying arithmetic to living organisms as if they were identical units. Life does not lend itself to analysis or classification. Where there is life there is individuality and variability, and man being the highest type of life exhibits the greatest individuality and variability, and hence cannot be sorted into groups as if each member were individually alike. Therefore, any conclusion drawn merely from statistical figures by handling and classifying men in different compartments as if they were so many bales of cotton can only have a limited application, though it has its uses in helping to present information in a convenient and practical way.

2. Experimental Aspect.

'Antiquity should not privilege error, nor novelty prejudice truth.'

Tubercle Bacilli and Acid-fast Saprophytes.—During the last few years the tuberculosis workers have more or less concentrated their researches on bacteriological and biochemical experiments to find out the physical and chemical characteristics of the tubercle bacillus and tuberculin, and their bearing on immunity. There is still a difference of opinion among experts concerning the constancy of type of tubercle bacilli and their relation to acid-fast saprophytes. While the more conservative school maintains that the acid-fast bacilli are well fixed in type, and that only acid-fast tubercle bacillus is derived and developed from acid-fast organisms, a change of type is recognized by many, including Eber, Dammann, Müssemeir, Rabinowitsch, Klimmern, Yabe, Ferran, San Felice, Wherry, Jaffe, etc. Since 1884, about fifty different strains of acid-fast bacilli have been found and described. Both the acid-fast saprophytes and tubercle

bacilli more or less closely resemble each other in their staining reactions, in possessing a large amount of lipase, and being able to thrive when ammonia, amino-acids, or acid amides are supplied as the sole source of nitrogen.

As early as 1883 and 1884 Mallasez and Vigual[6] described cocci and diplococci in tubercles which, they reported, were capable of passing into acid-fast forms. Dubard, Bataillon, and Terre[7] claim to have succeeded in inducing tuberculosis with paratubercle bacilli. Arloing and Courmont[8] in 1900, reported that they were able to transform the human tubercle bacillus into a form like the avian tubercle bacillus. Spengler described what he called 'the splitter'—a granular form of tubercle bacilli that occurred in certain strains, more especially in the bovine type. Much in 1907 described granules of tubercle bacilli that were different from Spengler's by being non-acid-fast and gram-positive, and capable of returning to the acid-fast forms. Sivory[9] in 1920 stated that resistant soil transforms tubercle bacilli into saprophytes, and cited experimental proof.

T. S. B. Williams[10] in 1911 showed that leprosy was probably derived from some species of streptothrix, and that acid-fast bacillary masses were merely phases of such a streptothrix and represented a resting and resistant stage of the organism. A. Foulerton[11] in 1912, confirming Williams's conclusions, observed that streptothrix and actinomyces are synonymous, and that in old cultures of streptothrix one finds larger or shorter bacillary forms, some of which may have a spiral or wavy appearance and short chains of spores resembling exactly streptococci and paired or isolated spores. The spherical spores of the streptothrix, on examination of cultures in artificial media, may appear in stained specimens as though they might be streptococci, diplococci, isolated cocci, or irregularly grouped staphylococci, and with most acid-fast streptothrices, as with Koch's tubercle bacilli, the acquisition of acid-fast properties is a matter of age. Claypole[12] in 1913 found group reactions to be common to acid-fast bacteria on the one hand, and to acid-fast and non-acid-fast streptothrices on the other, and

that streptothrices change gradually into mycelial, bacillary, and acid-fast forms by the process of evolution.

Kolle, Schlossberger, Pfanenstiel, and Igersheimer[13] in 1921 inoculated into guinea-pigs paratubercle bacilli which gradually became more virulent by passage through successive animals, and caused definite tuberculous lesions resembling the human type. Jaffe[14] goes further, stating that butter and timothy grass bacilli, avian and turtle bacilli, can call forth in the mouse necrotic lesions very similar to those of tuberculosis, and that the likeness is increased with animal passage. Ferran[15] of Barcelona believes that certain non-acid-fast bacteria as a result of parasitic life can be transformed into tubercle bacilli. In 1897, and at various times since, he has described a method of producing non-acid-fast organisms from tubercle bacilli by reducing gradually the peptone and then glycerine and sugar in the bouillon culture media, and eventually obtaining a saprophytic organism which was motile, ciliated, and non-acid-fast, and closely resembling the typhoid bacillus. By injecting these saprophytes into a series of guinea-pigs he succeeded in recovering the original form of tubercle bacilli. Auclair, and more recently Vaudremer,[16] have obtained similar results. In 1924 Karwacki[17] examined thirty-three pleural fluids, and reported a variety of cocci and diphtheroid organisms coming from acid-fast bacilli that he does not hesitate to call mutants.

Calmette, Gildersleeve, and Scultz,[17a] found that acid-fast timothy bacillus injected into the veins of rabbits produced tubercles with giant cells indistinguishable from those produced by tubercle bacilli. So also Moller, Korn, Mayer, and Lubarsh[18] were able to cause the development of true tubercles with giant cells in guinea-pigs with timothy and Korn bacillus. Lange[19] has recently reported that in the injection of tuberculin made from saprophytic acid-fasts in fifty patents, when compared with control reaction to old tuberculin in the same patients, he found no essential difference in the response to tuberculin made from pathogenic tubercle bacilli and that made from saprophytic bacilli. It has been frequently found that tuberculous patients and artificially

infected animals will react to tuberculins prepared from a variety of saprophytic acid-fasts.

In 1925 Pinner and Sweany[20] reported a pathogenic *B. subtilis* associated in tuberculosis, and also a *B. coli*-like organism disseminated throughout the body, not unlike Ferran's organism.

Now attention must be drawn to the work of Stephen Maher,[21] who has been experimenting on this subject since 1904. By cultivating smegma bacilli (acid-fast, but not alcohol-fast) in some of the fluid media, he obtained after a few days slight growths of non-acid-fast rods, which three weeks later by cultivating on tubes of glycerine broth potato he found growing colonies of both acid and alcohol-fast typical human tubercle bacilli, the emulsions of which, when injected into guinea-pigs, caused their death from tuberculosis. Again, on allowing cultures of *B. mycoides* to age in normal salt solution and in solid and semi-solid media, he found that about half of the small mycoides spores elongated somewhat and became acid-fast. This mixture of acid-fast and non-acid-fast, thickish or ovoidal rods and coccoids, when injected intraperitoneally into rabbits, were found to present a picture of moderate abdominal tuberculosis, and in the pus of the small nodules were acid-fast rods of the size and shape and tinctorial reactions of tubercle bacilli. These on culture, however, lost their resemblance to tubercle bacilli, and became again thickish ovoidal or coccoid rods, half acid-fast and half non-acid-fast. Both at the British meeting in 1920 and International Conference in Paris, 1920, Maher exhibited a strain of short acid-fast and alcohol-fast bacilli that he developed from the acid-fast spores of *B. subtilis* by subjecting them successively to normal salt solution and white of egg and human and sheep blood serum. Comparing the tuberculin reaction produced by old tuberculin with that produced by the acid-fast bacillus derived from subtilis, he found that forty-three out of forty-nine reacted to old tuberculin, while twenty-nine out of forty-nine reacted to subtilis, though it was less marked than the old tuberculin. Maher sums up his conclusions by saying that tubercle bacillus is only one

phase of bacterial cycle, that saprophytic varieties of tubercle bacilli exist in Nature, can be artificially produced, and can be made to become virulent tubercle bacilli.

William Stockwell,[22] following Maher's work, made many experiments, and obtained gram-negative motile bacilli by subculturing, as quickly as possible, one of Koch's old original cultures (H. 32) and using a bouillon U-tube sand filter. He also found gram-negative bacilli on repeating the same experiment with five other strains of tubercle bacilli, both human and bovine. No difference was noted in either cultural or staining characteristics between those derived from human and bovine strains. The gram-negative bacilli from bovine culture were distinctly shorter than those derived from the human strain, but after a few generations their difference was not apparent. Again, he took gram-negative bacilli and made subcultures from them on 6 per cent. glycerine egg, and alternately from this to 15 per cent. glycerine egg. Acid-fast bacilli appeared after many generations which were in all respects similar to the original culture (H. 32), thus completing the life-cycle of tubercle bacilli.

Probably the most interesting of Stockwell's observations were from a study of the morphological changes occurring when this gram-negative micro-organism was grown on different media. These changes were so great that it was hard to believe that they could have come from one and the same original micro-organism. A culture of this gram-negative micro-organism, which showed no gram-positiveness, was planted on plain agar, glycerine agar, whole egg glycerinized to 15 per cent., and Twort's medium, and the microphotographs (Figs. 1A to 1D) were made from smears on the fourth day stained by the gram method. Fig. 1A from plain agar is of bacilli that are entirely gram-negative, and granules which are both within the bacilli and also free are undoubtedly regenerative bodies. Fig. 1C from glycerine agar shows the bodies of the bacilli gram-negative, but the cocci or regenerative bodies are here gram-positive; they are seen within the bodies also free, and those free are large and swollen and many of them are 'tack-shaped.' Fig. 1B shows strepto-

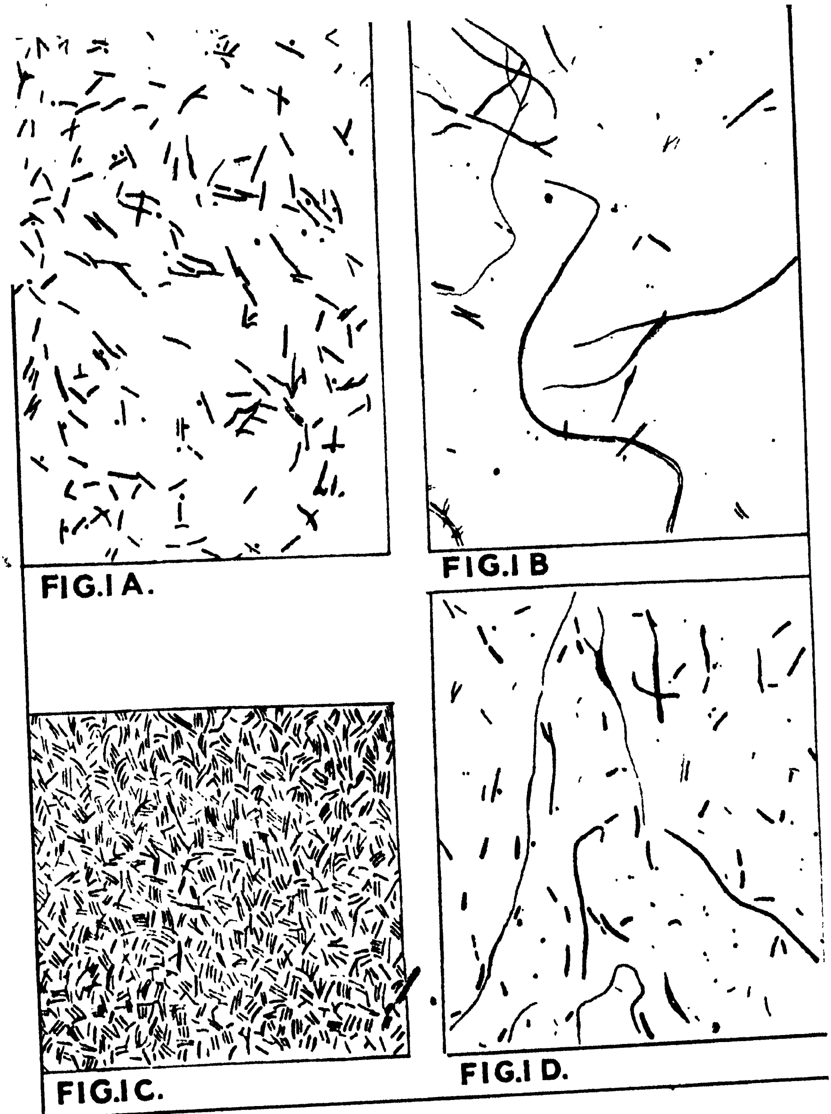

FIG. 1A.—A CULTURE FOUR DAYS OLD ON PLAIN AGAR-GRAM STAIN.
FIG. 1C.—A CULTURE SIX DAYS OLD ON 6 PER CENT. GLYCERINE AGAR.
FIG. 1B.—A GROWTH FOUR DAYS OLD ON 15 PER CENT. GLYCERINE WHOLE EGG.
FIG. 1D.—A GROWTH FOUR DAYS OLD ON TWORT'S MEDIUM ALL-GRAM STAIN.

(Reproduced by permission of Dr. William M Stockwell.)

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thrical forms of tubercle bacilli and regenerative bodies. It will be seen that these micro-organisms have characteristics of both tubercle bacilli and the colon group. On Twort's medium most of the micro-organisms are entirely gram-positive; the regenerative bodies are large and swollen, only a few of the micro-organisms are gram-negative, and these are thin and rod-shaped, more like the original plant. Fig. 1D is of the same tube as Fig. 1B, only six days older. Here the micro-organisms are broken up, and both gram-positive and negative ones may be seen, the arrangement of the granules being the same in both.

Not only Maher and Stockwell have obtained avirulent strains of tubercle bacilli, but Calmette and Guerin[23] grew tubercle bacilli for many generations on potato saturated with ox bile glycerinated to 5 per cent., and have produced a strain resembling the bacillus of glanders that does not form tubercles and is harmless to calves and new-born infants. Also, Nathan Raw has another strain of tubercle bacillus that does not produce disease of any kind.

More recently still, H. C. Sweany[24] in 1896 approached the problem from the standpoint of mutation, and prepared special cultures of tubercle bacilli in which all tests and controls were made to rule out contamination, and after many experiments came to the conclusion that under favourable environment tubercle bacilli develop mutation forms which assume a great variety of cultural, morphological, and pathological characteristics; that the two most common types of mutants are the bacillary (diphtheroids and solids) and coccoid forms (diplococci and tetrads), although filter-passing forms also appear to exist; that bacillary forms may pass over into coccoid forms and granules, and coccoid forms may grow into bacilli if the medium is suitable; that the mutation forms appear to develop from some of the gram-positive granules, which are perhaps resting stages of tubercle bacilli; that when cocci are formed, there is a tendency to develop first diplococci, and later various tetrads and staphylococcus-like forms, and also bacillary forms; and that many of these mutants are not pathogenic, many are of low pathogenicity,

while others undoubtedly play a definite rôle in disease processes.

All these experimental observations reported by so many different workers command our serious attention, though they seem heretical and revolutionary to the orthodox mind. They show unmistakably that the old view of fixity of type is untenable, and that in the presence of a suitable environment the acid-fast group of organisms alter their cultural, morphological, and virulent characters, and that, as Stockwell concludes, tubercle bacilli, when grown on different culture media, can be made to lose their acid-fastness, change into coccal or streptothrix forms, and lose their virulence, so that they are no longer able to produce tuberculosis in animals, and, to complete their life-cycle, can be induced to take acid-fastness again.

Does not all this evidence warrant us to construct a mental picture of these acid-fast saprophytes, and trace their life-history first through the soil, manure, and the water in which they are naturally found ; the dust, the skin, and mucous membrane in non-pathogenic form ; through plants and grasses like timothy grass (timothy grass is very well distributed in practically every pasture and meadow land in the British Isles), and through fishes and birds to higher mammals like cows, in milk and butter, dung and manure, changing their character and virulence as they ascend in evolutionary stages, finally to man ? Ferran[25] was not wrong when he proposed his 'ubiquity' hypothesis that the pathogenic forms of tubercle bacilli represent only a small branch of a group of organisms that are found widely distributed in Nature, and will become pathogenic when they become associated in the animal body. Indeed, all these acid-fasts—both saprophytic and pathogenic—are not only related to each other, but they also seem to have affinities with such organisms as *B. mycoides* and *B. subtilis* on the one hand, and *B. coli* and typhoid organisms on the other, as Ferran, Maher, Stockwell, and Sweany have shown.

Moreover, the mutant forms of tubercle bacilli open up wider possibilities if we would but enlarge our vision.

Vaudremer and Valtis[26] have described filter-passing forms that produce a tuberculous-like pathologic change. Sweany describes a group of acid-fast cocci which in turn appear to lengthen out into bacilli, and some of these forms are so small as to be filter-passing. In a series of experiments, in which he buried celloidin capsules containing tubercle bacilli in peritoneal cavities of guinea-pigs, he observed pure diplococci, streptococci, and tetrads in some of the capsules.

Pla[27] in 1924 considered coccoid and granular forms of organisms present in tuberculous lesions as a stage in the development of true tubercle bacilli, and not mutant forms. Putting these facts together with others already mentioned, may we not picture tubercle bacilli developing from filter-passing forms, gram-positive granules, granules of Much, and coccoid forms, or mutating into coccal, granular, and filter-passing forms? As Sweany observes, while some of the cocci derived from tubercle bacilli appear to produce tuberculosis with a return of acid-fastness, it may be possible to regenerate tubercle bacilli from cocci that have been removed only a few generations from the granules of Much, although so far it has not happened as a rule.

Another group of facts requires consideration. Karwacki, as we have seen, described a variety of cocci and diphtheroid organisms coming from acid-fast bacilli in the pleural fluids he examined. Many tetrad forms of cocci have been found in tuberculous cavities and sinuses. It is a common observation that tubercle bacilli suspended in certain pleural exudates very soon become non-acid-fast, granular, and coccoid morphology. As already shown, Sweany's experiments of tubercle bacilli placed in capsules and buried in the peritoneal cavities of guinea-pigs have mutated into coccal and granular forms. All these observations suggest that serous fluids (peritoneal and pleural) seem to have the power to modify tubercle bacilli into bacillary, coccal, and granular forms, such changes being brought about by the lipases and antibodies present in these fluids, as Karwacki explained, before they are finally destroyed or disposed of by the host.

If coccoid, granular, and filter-passing forms are mutants of tubercle bacilli, we can understand why sometimes tubercle bacilli cannot be found in well-defined cases of clinical tuberculosis, why all forms of cocci are found in tuberculous sputum, also why pneumonia is so closely associated with tuberculosis (p. 56). In this connection it is interesting to note that an alkaline extract of pneumococci can produce allergy with skin reaction similar to the allergic skin response of tuberculosis.

Lastly, Much's granules and coccal forms found in old tuberculous abscesses; tetrads found in tuberculous lesions; affections like Hodgkin's disease; the possibility of lymphogranulomatosis, polyserositis, Park's cirrhosis arising from some mutants of tubercle bacilli, as Sweany has suggested; a variety of avirulent acid-fast organisms found in pulmonary abscesses and gangrene; a condition of chronic peritonitis and pleuritis (which are identical with polyserositis in man), as seen by Krause [28] in inoculated guinea-pigs, instead of developing visceral tuberculosis; the Poncet type of arthritis—a tuberculous toxic form of disease; also a large class of tuberculous lesions of the skin, as lupus vulgaris, erythema nodosum, erythema induratum, lichen scrofulosorum and other tuberculides, pleurisy, etc.—all these many tuberculous affections open up a wide field of suggestion that a variety of diseased conditions may be connected with tuberculosis, many of which, if not all, may be caused or associated with some mutant or degenerate form of tubercle bacilli; that serous fluids may serve the purpose of excreting or neutralizing tuberculous toxins, and with skin and lymph glands may have a destructive or modified action on tubercle bacilli.

The Pathology of Tubercle.

In the pathology of tubercle, where the factors for the formation of giant cells are still not well understood, the following points read in connection with what has already been said (pp. 39 and 123) will interest the reader:

M. R. Lewis, H. S. Willis, and W. H. Lewis,[29] after a study of blood cultures (rabbit's blood), definitely showed that both

epithelioid cells and macrophages can directly come from the blood cells, the large mononuclears undergoing hypertrophy and exhibiting high phagocytic powers especially for red blood cells. Giant cells of the Langhans type form abundantly in cultures of whole blood from fishes, birds, and mammals. In these blood cultures the large mononuclears hypertrophied and became transformed into typical epithelioid cells, macrophages, and giant cells. The epithelioid cells and giant cells found in such cultures, and in cultures of lymph nodes and spleen with or without tubercle bacilli, are similar to those found in tubercles. All giant cells noticed in tissue cultures are from such tissues as spleen, lymph nodes, bone marrow, and blood—organs that are mainly concerned in maintaining and renewing red blood cells. Lewis and Webster found giant cells of frequent occurrence in cultures of normal and pathological human lymph nodes in human plasma. Since these cells form in the stagnant hanging-drop blood cultures and in cultures of normal human lymph nodes, there can scarcely be anything specific about the tubercle bacillus that is responsible for this transformation from blood cells, as Maximow has suggested. Lambert observed small giant cells in cultures of mouse tumour, and Creighton found (p. 180) epithelioid cells and giant cells in many forms of cancer.

Wolff-Eisner [30] is inclined to the view that in tuberculosis there is evidence of an exudative diathesis which is due to the absorption of proteins and protein fragments insufficiently degraded in the intestinal tract—*i.e.*, a protein sensitization —and that a relation exists between the diet and exudative diathesis and the tendency to effusion—pleural, peritoneal, and joint effusions.

All these observations seem to throw light on the views already expressed (in pp. 39 and 123), where as an explanation of the origin of tubercle and giant cells it is shown that impaired nutrition and imperfect formation of proteins lead to defective formation of red blood corpuscles, deficient oxidation, softening of the vessel walls, stasis, thrombosis, extravasation, phagocytosis, and formation of epithelioid and giant cells.

Tuberculin and its Reaction.

In spite of a large amount of investigation to find out the chemical composition of tubercle bacillus and its products, great uncertainty prevails with regard to the nature of tuberculin and many matters connected with its reaction.

What is tuberculin, and what is its specificity due to? Many observers believe that tuberculin is a protein substance, and owes its specificity to its protein character. Seibert and Long[31] assert that protein is definitely present after tubercle bacillus is allowed to grow in a medium which at first contained no protein, and that the activity of tuberculin is a function of its protein content; whereas Zinseer[32] has shown conclusively that extracts of tubercle bacilli from which all demonstrable protein has been removed by heat and acid coagulation are quite capable of eliciting a skin reaction in a tuberculous animal. It is amazing that even those who have grown the bacillus in non-protein media are not agreed upon the presence of protein in those products. Much holds that tuberculin reaction may be exhibited by lipase as well as by protein substance, while Vaughan and others assert that it is the toxic substance which is produced by the splitting of tuberculin by the body ferments that is responsible for the local reaction. After reviewing the whole subject, Wells[33] concludes: 'The possibility still remains that the active agent of tuberculin may not be protein at all, and the appearance of protein following the growth of bacilli in non-protein media may be a purely coincident phenomenon.'

Is cutaneous reaction due to living tubercle bacilli? Baldwin[34] showed that the skin reaction could never be produced without actual infection by the living organism, but Nakayana[35] says that tuberculin reaction does not definitely indicate the presence of living bacilli, and is not necessarily associated with the presence of tuberculous tissue. Also Petroff and Stewart[36] hold that the guinea-pigs sensitised with dead tubercle bacilli give an allergic reaction which in its

essentials does not vary from that observed in infected animals.

Is skin reaction peculiar to tuberculosis? That it is not so is shown by the fact that it has been observed to occur in a number of non-tuberculous infections, such as infections due to *B. typhosus*, *B. abortus bovinus*, *B. mallei*, *Spirochæta pallida*, pneumococcus, staphylococcus, and influenza bacillus. It is also observed by the injection of deutero-albumose and by non-specific agents, such as vaccines, proteoses intravenously and milk intramuscularly.

Skin Reaction and Specificity—Since the skin reaction is elicited by so many specific and non-specific substances, can its specific nature be maintained? Petersen[37] says that it is very probable that the tuberculin reaction, which for ordinary clinical purposes we may consider specific, has a very large element of non-specificity in its mechanism—much larger than is ordinarily considered probable. Even those investigators who have heretofore been the most ardent advocates of the specific character of the tuberculin reaction, such as Wolff-Eisner,[38] have been compelled to accept the inevitable conclusion that in the tuberculous individual the skin (and the body as a whole) is hypersensitive not only to tuberculin, but to proteins in general. Also Krause holds that constitutional symptoms of the tuberculin reaction are in a large measure of non-specific origin not dependent upon the toxicity of tuberculin alone. As so many substances produce a reaction that can hardly be differentiated from tuberculin reaction there develops, as time goes on, more opposition to the idea of specificity of tuberculin skin reaction.

Focal Reaction and Specificity—The positive focal reaction has been considered as proof not only of infection, but of activity of tuberculin as well. But the problem is not so easy of proof, as the focal reaction is bound up with inflammatory reaction on the one hand, and with non-specific injections on the other. Practically every inflammatory focus, irrespective of its etiology, will react (focal activation) to tuberculin as well as to a great variety of other agents, chemical or biological in character. Investigators in tuberculosis have long recog-

nized the fact that the tuberculous lesion responds with a focal reaction to a variety of substances. Baldwin mentions nucleo-protein, nuclein, albumoses, cinnamic acid, and cantharidin. Fishberg adds potassium iodide and creosote. Even non-tuberculous foci will respond to such agents. Also non-tuberculous processes will respond with a focal reaction to tuberculin. Schmidt has shown that the Poncet type of arthritis—a tuberculo-toxic form of disease—will exhibit a well-marked focal reaction following the injection of tuberculin; and when milk was substituted for tuberculin, he obtained exactly the same reaction at the site of the lesion during the same period of time.[39] In fact, as Peterson states, any circumscribed inflammatory process, irrespective of its bacterial etiology or its location, will frequently light up with a typical focal reaction after a non-specific injection, and usually within twenty-four hours after the injection. Only tuberculous lesions are perhaps more sensitive than these various processes, because of a more profound sensitization of the tissue cells of the host against protein in general, as Wolff-Eisner has suggested.[40] So that such a wide study of focal reaction does not warrant the conclusion that it can be a specific reaction.

As for the necessity of actual infection for the production of the tuberculin type of allergy, the studies of Zinseer, McJunkin, Petroff, and Lange[41] cast doubt on the belief that such an actual infection is necessary.

Allergy, Antibodies, Resistance, Immunity, and Specificity.

Our knowledge of the development of allergy and antibodies, of resistance and immunity reactions, their relation to one another, and the mechanism of their action in tuberculosis is not very clear at present. The opinion generally held by the medical profession is that tubercle bacilli form a specific antigen, evoke a specific allergy and antibodies, and bring about a specific resistance and immunity in the body. This idea of specificity is now challenged by the reactions of non-

specific therapy which have come to light in the clinical study of the defensive mechanism of the body.

Ever since Matthes in 1895 showed that the effect of tuberculin injection could be obtained equally well with deutero-albumose, it has been observed that profound physiological effects can be produced if infectious diseases and others are treated, not with specific antigen, but with proteoses and protein derivatives of many sources. We know now that febrile actions are not produced by specific antigen only. For instance, focal reaction in chronic gonorrhœal infection can be induced by other antigen than the gonorrhœal, and by still less specific agents such as casein or milk. The temperature in typhoid fever can be brought down by the injection of *B. coli* vaccine or substances like casein or deutero-albumose. Furunculosis can be benefited by *B. coli* or *B. typhosus*.[42] Favourable results have been obtained in clinical symptoms of general paralysis after a series of subcutaneous injections of tuberculin or by induction of malaria.[43] Most satisfactory improvement has resulted in rheumatoid arthritis by the administration of typhoid vaccine. Kroschinski[44] found that neuralgia, neuritis, tabetic pains, acne, and furunculosis have improved after Ponndorf's tuberculin injection. More than twenty years ago it was alleged before the Indian Plague Commission that anti-plague inoculations had cured eczema, gonorrhœa, and other miscellaneous infections. So non-specific agents, such as serum, various proteins, egg albumen, milk, gelatin, enzymes, gold and silver, sugar solution, salt solution, and even distilled water have been utilized in the treatment of typhoid, arthritis, gonorrhœa, dysentery, scarlet fever, asthma, skin disease,[45] etc.

What significance is to be attached to the presence of antigen, allergy, and antibodies? Are they to be considered as necessary factors in immunity reactions? The evidence that tuberculin allergy is an important factor in tuberculosis immunity is not complete. It is well known that specific antibodies may occur in the blood serum of men and animals apart from any obvious immunization with antigen. Many individuals are immune to certain diseases, and yet their

blood contains no demonstrable specific antibodies.[46] One animal may enjoy immunity without demonstrating the presence of any antibody in the body fluids, while another animal may show antibodies without necessarily being immune.

Again, we have no evidence that tuberculin and antibodies or antibodies and resistance are ever related. We know that febrile action can produce immunity without antibodies; on the other hand, they may be present in many patients with active progressive disease. Calmette[47] goes so far as to say that sera rich in antibodies may mobilize bacilli and hasten the progress of the disease.

Does Allergy indicate Resistance?—Allergy embraces hypersensitiveness to both protein and non-protein substances. Romer and Sata[48] reached the conclusion that a state of hypersensitiveness meant a certain degree of resistance, while Krause and Austrian believe that sensitization of non-tuberculous animals with tubercle protein does not raise their resistance to experimental tuberculosis infection, and, indeed, may lower it.

Coming to the subject of specificity considered as the sole basis of immunity, are we sure we know what specificity is and where it lies? It does not seem possible to explain natural immunity on a specific basis when, as we have already seen, that immunity to infection may occur in the apparent absence of antibodies, and that non-specific agents can release specific antibodies into the circulation, as the work of Conradi and Bieling[49] has definitely shown. The defensive mechanism of the body does not seem entirely specific in its action. If, as is alleged, biochemical specificity is based upon chemical individuality of proteins, how is it that non-proteins can act as antigens, and tuberculin reaction can be elicited by non-specific substances? Besides, how is it possible to speak of specificity with any certainty when we do not know the chemical composition of individual proteins? Our ignorance of the chemical structure of living cells and bacteria and of the products of cell metabolism prevents us from making much progress in our knowledge of immunity reactions.

The truth of the whole matter is that, whether specific or non-specific, we are in the dark concerning many of Nature's activities against disease. We do not know the mechanism of allergy or its relation to resistance, and in spite of much advance in the domain of bacteriology and immunology, the nature of immunity and the various reactions underlying immunity are still as great a mystery as ever. The more we try to penetrate this mystery by animal experiments and intensive research the more we are confronted with a maze of confusion and contradiction in the results and conclusions of expert workers.

The cause of much of this confusion is not far to seek. (*a*) Living substances cannot be chemically investigated during life. We know so little of the chemistry of normal tissues, and still less of the chemical changes that take place in those tissues upon which tubercle bacilli begin to grow. (*b*) Our reliance on animal experiments has been more a hindrance than a help in the elucidation of many problems connected with tuberculosis. As Kolmer[50] rightly says: 'The tendency for drawing conclusions on the basis of analogy with observation on the lower animals has tended to confuse the subject as applied to man.' Since it is doubtful, as Krause[51] observes, whether in a single instance an experiment on tuberculo-immunity has been conducted under conditions approximating those which must obtain in the course of ordinary human infection, how is it possible to draw any right conclusions from animal experiments? (*c*) In our zeal and enthusiasm in research work, we have concentrated our attention on tubercle bacilli and studied resistance and immunity from the viewpoint of bacteriology, and have not considered the increasing evidence of clinical success from non-specific therapy. (*d*) We have not understood that inflammatory reactions are a part of the healing process of Nature, and are therefore by no means specific. Life is more than what we see in the test-tube and the laboratory, is more than a mere collection of biophysical and biochemical reactions. The problems of immunity are broader-based than bacteriology. They embrace biological, psychological,

nutritional, environmental, and hereditary factors. Man is, after all, the chief actor in the drama of tuberculosis, and if we had studied the microbe less and man and his environment more, our pathway of research would not be beset with so many difficulties or strewn with so many wrecks of discarded theories.

While the orthodox workers believe in the specific reaction of antibodies and acquired immunity, the new school holds that, instead of being specific, any reaction is of the nature of increased natural defence of the body, and can be produced by non-specific remedies. Certainly the new school of non-specific therapy unfolds a wide outlook on life's activities by laying emphasis on the general protective mechanism of Nature in health and diseased conditions.

The Body's Defence.

1. Let us first glance for a moment at the mechanism of the body's defence in the natural state, beginning from the epithelium of the skin, the mucous membrane, and the activity of the enzymes of the skin, all of which act as the first line of defence. Bloch[52] expressed his conviction that the skin possesses an important biologic function, by means of which internal organs are protected against microbe infection. At any rate, the skin is fundamentally involved in the mechanism of resistance. Consider what a largely organized mechanism exists in the mouth, the nasal passages; how the sweep of the cilia brings about a rapid elimination of bacteria from the nose; how the tonsils stand guard at the gates, putting up a defence against the entrance of micro-organisms for years. And the mucous membrane of the upper air passages, the throat, the pharynx, the trachea and bronchi, and their rich supply of lymph vessels and lymphoid tissue—all of which act as effective barriers against the invasion of foreign particles or pathogenic germs. Note the action of the plasma, the antibodies, the lymph flow, the various secretions such as the saliva, the gastric and intestinal juices, the bile, etc., the phagocytic action which plays the part of a scavenger in picking up particles of dirt and bacteria, and engulfs

tubercle bacilli, which are destroyed by the intracellular enzymes ; lastly, the lymphoid tissue found all over the body, where the destruction of bacilli may be finally accomplished. As Gloyne[53] says, of all numerous devices which Nature has designed to keep watch over our bodily frontiers, that of lymphatic filtration is probably the greatest. So all through the way, at every step, every part of the body offers a strong, effective resistance to pathogenic microbes ; so much so that we can rightly question whether tubercle bacilli which may enter the mouth or the nose ever actually invade the body, and if they do, whether they ever get in without being destroyed by one or more of Nature's many activities.

2. Again, when the first lines of defence have broken down, the invasion of disease stimulates the body to an increased activity, causing inflammation, fever, exudation of leucocytes, increased production of tissue enzymes, phagocytosis, the destruction and elimination of the enemy, all of which form an integral part of the defensive mechanism of the body. The development of tuberculin sensitiveness is definitely associated with tissue reactions in the form of inflammatory processes, as Krause and Mueller have shown. Disease is nothing but a self-regulation or adaptation to abnormal conditions. This law of adaptation is a biological phenomenon. We have made a mistake in thinking that disease is the blow; instead, it is the physiological reaction of the body against the blow. Fever, inflammation, and other chemical reactions are curative processes, and are necessary for the elimination of disease. Did not Thomas Sydenham say that a disease is no more than a vigorous effort of Nature to throw off the morbific matter, and thus recover the patient ? Therefore the disease process is at the same time the healing process which lies potentially undeveloped in the body, just as creative evolution had anticipated man's fall, and had made provision for his uplift when human life first appeared upon this planet.

3. The inflammatory reactions which underlie the defence of the body, whether produced by injury, toxin, or bacteria, are fundamentally similar under all circumstances. If the

invasion be of the nature of a simple compound such as a drug or a poison, it calls forth nothing more than a simple reaction, creating a tolerance or habituation or a slight degree of resistance or rapid elimination, as in diarrhœa, but if the foreign substance is chemically complex as a bacterial toxin, it would evoke a complex chemical reaction. So the phenomenon of inflammatory reaction is not limited to bacteria, but represents general biological laws that govern the response of the living body to a large class of substances known as antigens, which may be a drug or a protein or a lipoid. Specificity would lie in the adaptation of the biological principles to individual conditions rather than in the principles of reactions themselves. As Ehrlich[54] truly said: 'The reactions of immunity after all represent only a repetition of the processes of natural immunity and their apparently wonderful adjustment to new conditions.' If scientific knowledge is illuminated by an intuitive insight, we should be able to see more or less fundamental analogies and close parallelisms in Nature's complex and incredible number of physical and chemical reactions with which she defends the body against foreign invasion. There is a close similarity between tuberculin reaction and the reaction produced by the sensitization with protein substance. There is much fundamental analogy between anaphylaxis and tuberculin reaction. The same substances may act as a common antigen and produce common antibodies. We can postulate antigenic similarity and essential identity of antibodies reviving the 'unitarian theory' of *Zinsser*.[55] At least, there is a strong likelihood that precipitins and bacterial and protective antibodies may be identical, as is indicated by the experiments of Bail and Tsuda.[56] And there is perhaps an identity of Abderhalden's ferments and specific antibodies.[57] To see life as a unitary whole is to see it in its true perspective, which is the beauty of true art. The West lays stress on divisions, analysis, compartments, and pigeon-holes; but the East with a truer insight sees rhythm, unity, synthesis, and continuity in life. So if our vision is far enough and long enough we can discern a simplicity in complexity, a unity in

diversity, all through Nature's physical and chemical adjustments.

Besides, the resistance of the animal organism is not brought about by a fortuitous or accidental meeting of the physical and chemical reactions with the pathogenic agents, but is the result of a deliberate, incessant, and unwearying struggle of the organism to get rid of the enemy from the system. Also in all the febrile phenomena, in the mobilizing of enzymes and the marshalling of leucocytes, in their attraction to the seat of injury (chemotaxis), in the phagocytic action, in the formation of antibodies, in the digestion, reduction, and disposal of toxins or bacteria, we perceive an orderliness, an intelligent purpose, and organization of the body cells which can well compare with any well thought out plan of a general in his campaign of war against an enemy. We may not understand the whole of the complex mechanism of resistance and immunity reactions, or the place of hypersensitiveness and antibodies in the actual scheme of immunity, but we can perceive in dim outline the simplicity, the unity, and the purpose underlying Nature's scheme of defence. The rest we can assume boldly with some certainty, if we combine a scientific sense with an enlarged vision and imaginative spirit.

4. **Allergy is not the Same as Resistance.**—It is generally followed by resistance, though not always so, in the same way that the demand for the payment of a bill does not necessarily mean it will be paid by the individual. Only if he has a balance in the bank will it be met. So any tissue sensitiveness will be followed by resistance if the vital forces are good, and in such a case the end result of resistance is immunity. This immunity need not be produced by anything specific. The result of inflammatory process leads to enzymatic action, lysis, and disintegration of tubercle bacilli, without involving any specific immuno-lysis, as Krause[58] has observed.

Such an immunity is not permanent, but is more or less transitory, and resides in the body cells and fluids as long as it is wanted to finish the work of healing which the organism

requires after the enemy's invasion. The workmen repairing a house remain in it with their tools, but once their work is finished they leave the house and take their tools with them. So immunity seems to disappear when tuberculous foci are healed up.

Besides, **the immunity is variable** according to the ebb and flow of the life-force within the organism. That the variation in the susceptibility to infection in experimental animals, though receiving the same food and subjected to the same living conditions, may be due to climatic and seasonal conditions is shown by the periodic fluctuation in the death-rate among normal animals and the high mortality level in spring and lower level in summer.[59] Tuberculous meningitis has maximum seasonal prevalence in spring and early summer. Twice as many cases occur in May as in October.[60] Epidemics of such diseases as cholera, plague, and malaria seem to be correlated with meteorological conditions, the atmospheric humidity and other climatic conditions taking their share in influencing the rise and fall of life-force and resistance and susceptibility to disease. Among sanatorium patients, as shown elsewhere (p. 261), the weight curve is lowest in late winter months and spring, and highest in summer and early part of winter. So the flow of vital force, among other things, may vary at different times and seasons, and with different nutritional and temperamental conditions. Besides, resistance may not altogether reside in the physical plane. It may be in the realm of the spirit, and so, like 'the wind that bloweth where it listeth,' may not be under man's control altogether. Nature has her moods and tides, her periods of depression and exaltation, and not knowing the time of her lowest or highest level of resistance, we blunder with our injections and fail to create an artificial immunity. But we do know that the body in its natural state is the best antigen, and in its robust health is generally most immune to disease. Since the basis of both specific and non-specific therapy is inflammatory reaction, which is a natural process, all we can do is to put the body in the most healthy condition possible, so that in case of any invasion of disease Nature may rise to

intervene at the right moment, mobilize the right materials that make for healing, give the right dose, and go the right way to bring about a natural immunity.

Resistance and Electrical Action.—Is there no connection between the resistance of the body and electrical action? Behind all the physical and chemical activities of the human body producing various juices and secretions, hormones and enzymes, catalysts and colloids, there lies ultimately the question of electrical cell action in the organism, which is truly a self-contained electrical machine, its energies of every kind being of electrical origin, and health itself being a human striving for the smooth working of an electrical balance between repulsion and attraction, between positive and negative electrons. In this twentieth century, when electricity is so much used in almost every human enterprise, it is not possible for medicine to lag behind the times and not utilize its energy for the good of suffering humanity.

The Electronic Reactions of Abrams.—The cause of truth compels the writer to bring before his readers the electronic reactions of Abrams, which he has been investigating since 1923. Though he has seen very good results by Abrams' method of treatment, his own experience is chiefly confined to the diagnosis and treatment of pulmonary tuberculosis. It is almost uncanny to see the reaction for tuberculosis come through when a drop or two of the blood of a tuberculous patient is placed on the dynamizer which is connected with the subject (who faces the west and is grounded) and the rheostat set at the vibratory rate of forty-two, which is the vibratory rate for tuberculosis. Almost every case of tuberculosis has elicited on percussion a dulness just below the umbilicus, where lies the area of dulness for tuberculosis. The writer is more struck with the accuracy of the diagnosis than the treatment. The varying results may be partly due to the present imperfect knowledge of reflexes and energies lying within the body and the want of their control by more finely-tuned instruments. Abrams' instruments may not be perfect, and many attempts are being made to improve them in America and in this country,

notably by Dr. William E. Boyd, of Glasgow. From what he has seen, the writer is convinced that the reactions are in the nature of radio waves, that health and disease are in future going to be interpreted in terms of electronic vibrations and wave lengths of energy, and that the diagnosis will be based upon electronic reactions and the treatment upon their elimination from the body. And Albert Abrams will stand for all time as the discoverer of three concepts: that disease is due to the disturbance in the electrons of the atom, that the energy emanating within the atom can be intercepted and made to betray the character of the disease, and that tuned electro-magnetic waves can be used in the treatment of disease.

3. The Clinical Aspect of Tuberculosis.

'Pathology is still shifting. We have not reached finality. Even bacteria are probably results and not causes.'—Sir James Goodheart.

Tuberculosis and Infection.

It has been taken for granted that the universal prevalence of tuberculosis is due to a widespread infection in civilized countries, and yet, as Tulloch[61] and his co-workers have said, we are wholly ignorant of the mechanism of invasion that determines infection in tuberculosis. It is generally believed that most people are infected in childhood. This prevalence among children can be brought about by exposure and contact with infection or through drinking tuberculous milk. Is every tuberculous child infected by its parents? What if there is no tuberculosis in the family? Krause[62] believes that children are infected by raw sputum from tuberculous cases conveyed from hand to mouth. But the acceptance of such a method of contamination of children with tubercle bacilli presupposes a universal contact of all children with tuberculosis— an assumption for which there is no evidence. There are hundreds of children who are brought up in homes where there are no cases of tuberculosis.

Besides, mere exposure to, or contact with, tuberculosis

cannot cause the development of the disease. If contact with tuberculosis is the cause of the widespread infection, there should be an overwhelming proof that the children of tuberculous parents are attacked in greater numbers than those whose parents are free from the disease. Presuming that tuberculin reaction is an index of tuberculous infection, Drolet[63] has shown that out of 1,234 children from five to fifteen years of age seen in Belle Vue Tuberculosis Dispensary, New York, with a history of contact with tuberculous parents, 790, or 64 per cent., gave a positive reaction, whereas out of 461 children with no parental history of tuberculosis 66 per cent. yielded a positive reaction. Also, Austrian[64] gives 68 per cent. of positive reaction in children without known exposure to tuberculous infection, and 64 per cent. among those living with parents without clinical tuberculosis. These figures mean that actually there is slightly greater prevalence of tuberculous infection among children without parental history of tuberculosis than amongst those who had no such contact with the disease. At any rate, tuberculous infection seems to be as common among children with a parental history of tuberculosis as among those who give no such history of contact. In Papworth Colony, Cambridge, England, we find not a single case of tuberculosis has yet arisen amongst the children of the colonists living in the villages attached to the institution.[65] Also in the Home Hospital, New York, where tuberculosis is treated as a family problem, and where consumptives live with their families, it is found that after ten years' experience no healthy person has acquired tuberculosis through coming into contact with tuberculous patients.[66]

Dr. Ford,[67] tuberculosis officer, Hertfordshire, investigating the history of over 1,000 cases of pulmonary tuberculosis, found that a very large number (almost 80 per cent.) of cases gave no family history of tuberculosis. Besides the instances already given (p. 23) of workers in sanatoria in contact with consumptive patients, one or two others may be cited here. In one series of over 1,000 presumably non-tuberculous employees in North-Eastern Minnesota Sanatorium,[68] United States, there have been only ten cases of definite clinical

tuberculosis. Toan[69] reports four cases of the disease developing among 857 non-tuberculous employees at the Michigan State Sanatorium. Among 1,115 patients at Minnesota Sanatorium, 34 per cent. gave a history of exposure and 66 per cent. did not; and out of 587 sputum cases, only 29 per cent. gave a history of exposure to tuberculosis and the rest did not. Taking all the evidence together, both among children and adults, we find that exposure to infection has not produced any more tuberculosis than can be accounted for in a natural way under civilized conditions, and that a parental history of tuberculosis is as common among persons who show no evidence of tuberculosis as it is among those who have definite clinical disease.

Infection through Milk.—We have elsewhere gone into this question, and have shown that the poor, who drink less milk than the rich, have more tuberculosis, and the Oriental races, including the Indian, the Japanese, the Chinese, etc., whose children drink little or no milk, have as much tuberculosis, if not more, than the European races. If cow's milk is the source of children's infection with tuberculosis, the incidence of tuberculosis in children and cattle in different parts of an agricultural country like Sweden should show some correlation—*i.e.*, the parts of the country which have the greatest number of tuberculous cows should show most cases of tuberculosis among children. Dr. Adolf Lichtenstein,[70] of Sweden, in the course of his investigations in the large county of Norrbotten, in the north of Sweden, found that, although bovine tuberculosis is practically unknown (only five animals were known to be tuberculous), the county showed a very high tuberculosis death-rate among infants under one year and children under the age of five years; so high is the death-rate that it is only surpassed by Stockholm. Whereas Kristianstad, with the incidence of bovine tuberculosis the highest in the country (26 per 10,000), has almost the lowest death-rate from tuberculosis in infancy. And this disparity was observed in several other counties, a high infantile death-rate being recorded with little bovine tuberculosis, and *vice versa*. So there seems to be no inter-

dependence between the incidence of tuberculosis in children and bovine tuberculosis, as one would expect if one is the cause of the other. Again, at the large agricultural college of Aas,[71] in Norway, Dr. Thesen noticed that, though the cattle were saturated with tuberculosis, and their milk was consumed unboiled by the children of the staff, yet in a period of about forty-three years no incidence of tuberculosis, far less any death from tuberculosis, occurred among these children. Going to another part of the world, the writer, in his extensive travels in India, found that, while the Indian cattle suffer from little or no tubercle, there is yet a great prevalence of tuberculosis among all classes of the Indian people, both among children and adults.

It is only by gathering such evidence from different parts of the world that we can arrive at the truth that exposure to infection or milk cannot be the true cause of such a wide distribution of tuberculosis in childhood. Clearly there are other factors that are involved in the spread of tuberculosis. Many hundreds of thousands are continually exposed to tuberculosis and drink tuberculous milk, but get no tuberculosis, while equally as many not so exposed to infection and who do not drink tuberculous milk yet get the disease. Why? The etiology of tuberculosis lies deeper than infection with tubercle bacilli. There are two causes of disease—the external and internal, the visible and invisible, the material and the mystic, the seed and the soil. The soil is more important than the seed, as resistance is more important than infection. However perfect and selected the seed corn may be, if it is sown in a soil of gravel and sand it will produce no harvest. So no amount of microbes can produce tuberculosis if a man's constitution is robust and resistant. Behind microbe and infection there is the social and economic background which predisposes the soil and activates disease. As McCarrison[72] says: 'Bacterial agencies are often but weeds which flourish in soil made ready for them by dietetic defects.' Such a soil must be prepared before tubercle bacilli can produce tuberculosis. This is why Sir James Goodheart[73] said that bacteria come as results (of soil) and not as causes.

Bacteriology lays stress on the external cause and takes too narrow a view of disease causation. The germ theory of disease does not explain a fraction of all the pathological phenomena, or cover all the facts of life or of clinical experience. It is man—the material and spiritual man—through his vital resistance that finally determines the causation and cure of tuberculosis.

The Diagnosis of Tuberculosis.

Tuberculin and its Clinical Significance.—We have a conflicting mass of data on the subject which requires a careful examination on all sides to unravel the main points at issue. What is the significance of tuberculin reaction in the diagnosis of tuberculosis? Does the positive reaction indicate the presence of infection or activity or resistance and immunity? At the very outset we must agree with Professor Debré[74] when he points out the fallacies and difficulty of estimating the frequency of tuberculosis in children during the first two years, either by Pirquet reaction or by tuberculosis mortality among children of this age. While Austrian[75] believes that sensitiveness to tuberculin is a valid index of the presence of tuberculous infection, Armstrong,[76] on the other hand, says that it measures the resistance of the child to infection. According to Marfan, positive reaction is an indication that living tubercle bacilli are present somewhere, irrespective of activity or inactivity of a lesion, but Nakayana holds that cutaneous reaction neither definitely indicates the presence of living bacilli, nor is it associated with the presence of tuberculous toxin. While Baldwin[77] showed no absolute relation between the degree of sensitiveness and the stage of disease, Krause[78] asserts that the skin sensitiveness develops simultaneously with the development of initial focus, increases progressively with the lesion, and varies directly with the extent and intensity of infection, and diminishes with healing. It is reported that in Westphalia, Germany, a group of poorly nourished children gave a higher incidence of reaction than did groups of well nourished or moderately well nourished

children, whereas in Australia healthy school-children gave a far higher percentage of positive reaction than the children in the hospitals. In opposition to the findings of Erlandsen and Petersen,[78a] the healthy, and to a less degree the suspects, showed greater allergy than those with tuberculosis. Such a difference of opinion is further complicated by the fact that non-specific agents can also give a reaction like tuberculin. Observe also the variation in the positive reaction in children even in the same country. Drolet reports positive reaction in 85 per cent. among 871 children in New York, while Slater gives only 10 per cent. in rural Minnesota. In an industrial school near Edinburgh, McNeil[79] found 60 per cent. of boys reacted positively, while not far away in a similar school only 14 per cent. reacted positively. Under these circumstances, how is positive reaction to be interpreted? Dr. Penfold[80] of Australia reports that among patients suspected of clinical tuberculosis 68 per cent. gave a positive reaction, and with no clinical signs 59 per cent. gave positive reaction. At Sydney, with no evidence of tuberculosis, 58·7 gave positive and 41·3 gave negative reaction. In Minnesota Sanatorium clinically non-tuberculous employees gave 39·3 positive and 60·7 negative reaction. This means that both positive and negative reactions can be elicited both in those who have and those who have not any clinical signs of tuberculosis. While with a positive reaction an individual can enjoy perfect health and show no sign of tuberculosis, it is not possible to assert that a person reacting negatively has never been infected. Children may positively react at one time and negatively at another time, and how are we to interpret their reactions? Since tubercle infections may die out and tuberculous foci may heal up, we cannot determine by tuberculin test how many children or persons have been infected, as we formerly believed we could. Further, Armstrong[81] of Framingham, after a thorough medical examination of all the children with negative and positive reaction, did not find a single case that could be called active tuberculosis, and a subsequent follow-up during a period of years brought forth not a single case of active tuberculosis

among those children who had shown a positive reaction. All this means that a positive reaction either in children or adults does not indicate that the individual has clinical tuberculosis or will have it in the future, and a negative reaction does not mean that he has not or is not likely to have the disease. The results of workers have been so contradictory that one cannot say with any certainty what tuberculin reaction signifies. Reviewing the whole subject, all one can say is that a positive reaction most likely indicates a tuberculous soil and nothing more. It is really a delicate test of protein sensitiveness brought about by the absorption of products from the imperfectly formed protein in the system. (We will develop this theme later on.) As Zinseer says, actual diagnostic value of the reaction has lost considerable weight, since in human beings the test is so delicate that over 70 per cent. of adults react positively.

If positive reaction indicates anything at all, it signifies a measure of resistance to tuberculosis, as Drolet and Armstrong have shown. This may be the reason why there is no reaction when resistance is lowered, as in children suffering from measles, in the late stages of pregnancy, in cachexia, in advanced cases of tuberculosis, or at certain seasons of the year, as Hamburger noted; also in scorbutic tuberculous animals (fed with foods deficient in vitamins), who give a less well-marked skin reaction than non-scorbutic tuberculous animals. The idea that tuberculin reaction is related to resistance is further strengthened when we study its effect upon the skin. As Petersen[82] has pointed out, tuberculin sensitiveness may be largely due to the action of the skin itself, and the difference of the skin reaction in childhood and adults may be due to the different enzymes they contain. The infant or young skin contains more ereptase and little lytic proteose, and so is not able to split the protein, and consequently no toxic products are formed and there is no skin reaction. Whereas in the adult the presence of sufficient proteose in the skin will permit the protein to be broken up with the formation of protein split products toxic to the cells and an inflammation will be the result.

Again, Hoffman[83] makes the epigrammatic statement that 'the skin is the grave of the parasites.' The fact that so many acute exanthemata, such as measles, scarlet fever, smallpox, etc., involve the skin, has led him to the conclusion that the skin plays an active rôle in immunity. Indeed, as Heim has observed, it is one of the beliefs of folklore (it is held in India and other Oriental countries) that the organism endeavours to rid itself of the toxic substances through the skin, and that in skin diseases and acute exanthemata the greater the manifestation of eruption on the skin the more it protects the internal organs, and the more favourable is the recovery of the patient. This is also true in syphilis, where patients with tabes or general paralysis seldom give a history of serious skin involvement, and in tuberculosis, where it attacks the skin, as in lupus, the lungs and other organs are spared.

In heliotherapy the effect of skin exposure to sunlight, in causing a rise of temperature and pulse and general malaise, resembles that of tuberculin reaction. Similarly the artificial production of inflammatory reaction, as in tuberculin injection, seems to indicate that the protective action of the skin plays an important rôle in resistance and immunity in disease like tuberculosis.

To sum up, the tuberculin test is more or less unreliable in the diagnosis of tuberculosis. The positive reaction is not an indisputable evidence of tuberculosis in children or adults, for it can never decide with certainty an otherwise doubtful diagnosis. It is not specific, as so many non-specific substances yield a reaction similar to tuberculin. Besides, the skin sensitiveness is fundamentally involved in the mechanism of resistance. The difference in the tuberculin reaction may be due to a difference of the enzyme action of the skin in children and adults, or to the tissue resistance of the host rather than to any difference in the virulence of tubercle bacilli.

Other Aids in Diagnosis.

No specific tests have so far proved to be of any real value in the diagnosis of tuberculosis.

Arneth's differential count is unreliable.

X-ray examination is a valuable help, but in the absence of clinical findings X ray alone is not sufficient to give a positive diagnosis of tuberculosis. As Dr. Logan Stewart[84] has said, it is a more reliable negative than a negative sputum result.

Complement-fixation test has given negative results in so many cases that it cannot be considered as a diagnostic aid.

As for the sedimentation test, there is conflicting testimony on the subject. H. N. Cooper[85] says that the increased rate of sedimentation of the red cells occurs in diseases attended by tissue degeneration and destruction, as in acute inflammations, pregnancy, tuberculosis, and malignancy. Since so many other conditions can accelerate sedimentation, its diagnostic value is doubtful. Kutz, L. Rabinowitsch, and Kempner[86] find that neither the Pirquet test nor complement-fixation nor sedimentation of erythrocytes gives absolutely reliable results in tuberculosis.

Tubercle Bacilli in Sputum.—While fairly diagnostic of tuberculosis, the positive finding does not indicate activity, nor a negative finding an absence of tuberculosis. There is a likelihood for acid-fast organisms in milk, butter, etc., to be mistaken for Koch's tubercle bacilli. Also various mutant forms of tubercle bacilli, as previously pointed out, may accompany tuberculous disease in the absence of Koch's bacilli. We must bear in mind that there are active manifest cases of pulmonary tuberculosis in which tubercle bacilli cannot be determined during years of observation, one reason being that there are cases of simple phthisis with all the symptoms of clinical tuberculosis, but without the presence of tubercle bacilli in the sputum. Such a clinical manifestation has led Batty Shaw[87] to call such cases 'simple consumption' or 'simple phthisis pulmonalis,' and to reserve the term 'tuberculo-consumption' for those cases where simple

consumption becomes complicated by the presence of tubercle bacilli in the sputum. Besides, as Bezançon[88] rightly says, it is dangerous to think that the finding of tubercle bacilli is indispensable for the diagnosis. We should be able to diagnose the presence of the disease long before tubercle bacilli make their appearance in the sputum. As the writer has often said, for accuracy of diagnosis nothing can supersede the physical signs if the eyes and ears are kept trained and tuned to all the fine perceptions. There is a tendency in some quarters to exaggerate the value of body temperature at the expense of physical signs in the diagnosis and prognosis of pulmonary tuberculosis. True, we may not always depend upon physical signs alone. One day there may be heard many crepitant rales and the next day they may all disappear. So also there may be normal or subnormal temperature, and yet the patient may have extensive disease. Therefore the physical signs should be studied, together with temperature and pulse and the general condition of the patient, before arriving at any diagnosis. It is truly regrettable that the art of physical examination is being gradually lost by X-ray and bacteriological methods. In these days, when early diagnosis of pulmonary tuberculosis is coming to be more and more an absolute necessity in the interest of the patient, his family, and the State, the cultivation of a fine sense of hearing and observation becomes of the highest importance to medical men, both in diagnosis and treatment of the disease.

Diagnosis by Lipiodol Injections.—In the difficult diagnosis of tuberculous cavities, bronchiectasis, gangrene or abscess of the lung, and chronic emphysema, the real nature of the lesion may be seen when X-ray pictures are taken after lipiodol injection. A small canula is introduced between the thyroid and cricoid cartilage, ½ c.c. of 1 per cent. of novocain solution injected to anæsthetize the skin, and 15 to 20 c.c. of lipiodol (a French preparation of iodized vegetable oil containing 40 per cent. of iodine) or iodized oil heated to 45° C. is introduced with a strong syringe, the patient lying on the operating table, and radiographs taken after the

injection. In some cases the lipiodol treatment appears to have a curative action on the suppuration of the cavities, and to bring about an improvement in the general condition of the patient. On the other hand, Archibald and Brown[89] point out that there are definite potential dangers accompanying the intratracheal injection of iodized oil. Singer and Graham advise against the use of lipiodol in cases of bronchiectasis, as it is apt to cause foreign body complications, such as local inflammatory reactions, retention of infectious material, or mechanical reduction of the vital capacity. Sergent, Armand-Delile, and Moncrieff state that patients with tuberculosis should not be submitted to this method, because of the danger of the congestive action of iodine.

Early Diagnosis.

Tuberculosis is not a well-defined disease in the early stage. It is so insidious, its commencing symptoms are so vague, and the slight deviations of ill-health so imperceptibly shade off into early tuberculosis, that no wonder thousands of cases are missed rather than mistaken for tuberculosis. Therefore, the real fear does not lie, as Rist thinks, in making a wrong diagnosis, but, as Kuss observes, in the failure to recognize the disease in the early curable stage. The great majority of active cases are only recognized at a late stage. Clinically recognized, tuberculosis is really an end process, and therefore to wait for definite symptoms such as X-ray findings, moist rales, and positive sputum is to wait too late for effective treatment.

Early Diagnosis in Children.—In children early diagnosis is of utmost importance. One cannot tell with any certainty to what extent pulmonary tuberculosis is prevalent among children. If we take into account all the slight departures from health that may or may not lead to clinical tuberculosis, and all the mild undiagnosed cases that remain unsuspected, we should say that the disease is very common in childhood, though a great majority get well.

What are the essential symptoms that establish tuber-

culosis in childhood? The early symptoms are very vague, and marked by many conditions of ill-health.

(*a*) In the pre-tuberculous stage one must take note of any family predispositions, hereditary traits, and premonitory symptoms, such as either a fine delicate skin, clear bright eyes, long silky eyelashes, long thin neck, prominent superficial veins, enlarged cervical glands, or a strumous type with heavy appearance, opaque skin, large hands, thick bones, and enlarged glands. Both types are accompanied by debility, under-weight, chronic colds which may go on for months or even years, or lead to some definite symptoms of the next stage.

(*b*) **Physiological or Suspected Tuberculosis.**—Here one often notices symptoms of poor economic and bad hygienic conditions, such as impaired nutrition or malnutrition, under-weight or emaciation, lassitude, capricious appetite, irritability, nervousness, attacks of fever that cannot be explained, chronic catarrh, restlessness, fatigue, bad teeth—symptoms mostly due to a chronic want of fresh air, good food and healthy surroundings, or gastric disturbance and want of assimilation, and vitamin deficiency. Malnutrition seems to lay a foundation for tuberculosis.

(*c*) **Pathological or Early Tuberculosis.**—Here the febrile attacks become more frequent, with flushing in the afternoon; the child is moody, fretful, tired, pale, complains of headache and feeling ill, is losing flesh, the wasting marked at the back of the neck; the skin may be dry, glands enlarged in the neck and other parts, etc.

In the first two stages there may be no physical signs Even in the early third stage one cannot rely upon any alteration in the percussion note or X-ray indications. But later there may be paravertebral or sternal dulness, harsh breathing, granular inspiration, cogwheel, D'Espine's sign, whispering pectoriloquy (heard below the second dorsa, when the child whispers 333), abnormal hilum shadows. Enlarged glands may be the result after measles or whooping-cough, and need not necessarily point to tuberculosis, though these affections often light up the disease or pyogenic

glands may rapidly become tuberculous in course of time, as Still has shown. The symptoms are often more important than physical signs or X-ray findings. When one finds in children continued poor health, attacks of unexplained fever, repeated colds, cough or hoarseness, lassitude, wasting, poor or capricious appetite, with or without physical signs, such as areas of dulness, roughened inspiration, and crepitant rales at the apices or roots of the lungs, it will be justifiable to suspect a tuberculous state, and commence treatment at once by placing them under fresh-air conditions, good food and rest, or sending them to a convalescent home, rather than wait for the further development of the condition, which may become tuberculous if the child is not given early attention.

With regard to the early manifestation of pulmonary tuberculosis in adults the reader is referred to Chapter XIII. Here we can only emphasize that early tuberculosis (or occult or minor or mild tuberculosis, as it is sometimes called) often begins with gastric symptoms, with loss of appetite, constipation, a vague sense of ill-health or general malaise, or nervous symptoms such as sleeplessness, irritability, nervousness, inability to concentrate on work, followed by a small rise of temperature, increased on exertion, quick pulse, with impaired resonance, cogwheel, roughened inspiration, and harsh breathing over one apex or both apices, with or without crepitant or crackling rales over those parts. Under these circumstances one is perfectly justified in diagnosing early tuberculosis, and in not waiting for the appearance of tubercle bacilli in the sputum, but should recommend the patient to give up work and take a change of air or commence open-air treatment, preferably in a sanatorium. Pleurisy and hæmoptysis occurring in apparently healthy people are important symptoms in the pre-tuberculous stage. Such cases should be placed under treatment where they would have every chance of recovery.

The Treatment of Tuberculosis.

Up to the present time no specific remedy has been found to destroy the tubercle bacilli in the body. All attempts to kill them by the use of immunological and chemotherapeutic

remedies have brought nothing but disappointment. The failure of tuberculin as a specific and certain cure in pulmonary tuberculosis is now generally admitted. We have seen such disastrous results from tuberculin treatment (especially in susceptible people like the Indians), which seems to light up into activity a quiescent disease, that we quite agree with Webb, Ryder, and Gilbert when they say that it is dangerous to introduce into a susceptible animal any sort of material containing tubercle bacilli which are not positively known to be dead.[89a]

Any reported beneficial result of tuberculin and other remedies is probably due to inflammatory reaction brought about by 'protein shock,' and not due to any specific action against the germ itself. The long line of therapeutic measures beginning with various tuberculins, vaccino-therapy, sero-therapy; specific treatment such as Spahlinger's vaccine, Dreyer's diaplyte antigen, gold salts (gold and pearl have been used in India as a remedy for consumption from time immemorial) such as krysolgan, aurocanton, and more recently Mollgaard's sanocrysin; drugs such as creosote and guaiacol, calcium and silica, iodine and lipoid treatment, sodium and iron cacodylate, sodium and ethyl morrhuate, and very many more—one by one they come and go, 'they have their day and cease to be.' In spite of so many failures the search for a specific agent, for 'magic bullets,' as Ehrlich has called them, goes on unceasingly in every country. But it is a vain hope. There is no short cut in the cure or arrest of tuberculosis. So we must fall back upon Nature's method, upon improving the soil, stimulating the natural defences of the body, and increasing the powers of resistance by such hygienic and dietetic measures as fresh-air surroundings, nourishing food, more or less complete rest, and judicious exercise—measures which form the main principles of sanatorium treatment.

Sanatorium Treatment.

After twenty-seven years of sanatorium experience the writer can speak with full assurance that, given a reasonably

early case and a well-trained and experienced physician, the sanatorium treatment holds out the best hope of success in the treatment of pulmonary tuberculosis.

As early treatment is so essential to sanatorium success and to the reduction of tuberculosis mortality, the medical profession should concentrate its attention on the study of early diagnosis rather than wait for discovery of a specific remedy. Then both the children and adult sanatoria will be used as preventive institutions for early or suspected tuberculosis rather than for advanced and hopeless cases, as at the present day. The results of sanatorium treatment will mainly depend upon the proportion of early cases treated by an institution; the greater the number of early cases the larger will be the proportion of recovery and arrest of the disease. From his long experience in the treatment of pulmonary tuberculosis the writer finds that he can chiefly rely upon sanatorium treatment, graduated exercise, and inhalation treatment. To these two more remedies can be added: compression of the lung by pneumothorax, etc., and heliotherapy.

Sanatorium Treatment.—As we have already gone fully into the matter, only a brief statement is necessary here.

(*a*) Fresh air, open windows, the body kept flushed all day and night with pure air, free country life, light and loose clothing, without stiff collar or hat or braces or boned stays.

(*b*) Food, more or less ordinary fare, no overloading, consisting chiefly of a little meat, eggs, fish and poultry, wholemeal bread and butter, plenty of fresh green vegetables, potatoes cooked in their jackets, green food like salads, tomatoes, fruit, cheese, fresh milk, and if the gastric organs are inclined to be upset little or no milk. China tea in preference to Indian tea, malted cocoa. If vegetarians, meat is not necessary if animal proteins can be supplied by milk, eggs, and cheese.

(*c*) Rest in a lounge chair with an adjustable back, the patient kept in calm and peaceful surroundings, cheerful and happy, and, if possible, relieved of anxiety (financial and

otherwise) concerning his loved ones at home. Physical, mental, and emotional rest are very necessary in the early part of the treatment. Rest helps to limit the movement of the chest, and should be enjoined as long as there is active disease and temperature. In considering the relative value of rest and exercise, it is better to err on the side of giving more rest than in giving more exercise.

(*d*) Exercise. The writer lays as much stress on all kinds of exercise as on rest. Nothing demands so much skill and judgment on the part of the physician as in regulating the proper amount of rest and exercise for each patient. Walking, beginning from five, ten, or fifteen minutes, and gradually extending to one and a half hours in the morning, and one hour in the evening; then gardening, chopping and sawing wood, carpentering; then extended walks, tramping, breathing and singing exercises, etc.—all arranged, graduated, and varied by the medical superintendent. Exercise brings all the benefits of a mild focal reaction, as it is Nature's reaction. The temperature should be watched to see it does not go beyond 99·0° or 99·2° F. (oral method), but no prognostic importance can be attached to the height of temperature after slight exertion, as Würtzen and Holten[90] found that non-tuberculous persons could show quite as high temperature after exercise as the tuberculous. Many in both classes may actually show a fall of temperature directly after a slight exertion. Dr. H. J. Rae, of Aberdeen, finds fault with graduated exercises as carried on in some places, and recommends what he calls 'remedial exercises' such as electrical message, and chest-developing exercises. For the last twenty-five years we have been carrying out graduated and chest-developing exercises in our sanatorium after the disease has been quiescent with perfect safety and great benefit, and we have not found patients 'soft' with 'flabby muscle' on leaving the sanatorium. On the other hand, patients returned home more or less perfectly fit to take up their various duties. We would therefore strongly recommend these exercises as a part of the sanatorium treatment. Whatever form the exercises may take, their virtue depends upon

having them carried out daily, efficiently and enthusiastically, according to the needs of each patient, by the chief of the staff.

So, lastly, it is the physician at the head that makes or mars the success of a sanatorium. It is not the best equipped institution, but the most capable physician with enthusiasm and personality, that ensures the best results. While it is necessary to keep the patients from dull monotony, is there not a tendency at the present day to relax discipline and allow too many amusements which keep the patients in a constant state of excitement? After all, the old régime which entailed a great deal of quiet and restfulness yielded the best results. In these days the sanatorium physician may find it difficult to maintain discipline and yet allow such relaxation as the circumstances demand.

Inhalation Treatment.—The writer believes that the inhalation treatment as carried out in his sanatorium (see Chapter XVII) is an important aid in the arrest of pulmonary tuberculosis. It is especially beneficial in those cases which are associated with catarrhal conditions, bronchitis, laryngeal tuberculosis, etc. It allays cough, soothes the inflamed mucous membrane, and prevents any infection from spreading down from the nose and throat. It has also a mental effect, and keeps the patient quiet and ensures a restful condition. To get full benefit it should be used with steady perseverance. Both the writer's mask and inhalants are manufactured by Messrs. Oppenheimer, Son and Co., London.

Compression of the Lungs by Pneumothorax, etc.

Rest is the chief factor in the treatment of almost all diseases, including tuberculosis. Webb[91] says that in breathing, a normal person opens and shuts the lungs nearly thirty thousand times a day. Since the constant movement of the lungs and frequent cough are important agents in the absorption of toxins from the diseased lung and their dissemination into adjacent healthy parts, any measure that limits the respiratory excursion lessens the work of the lungs and the frequency of cough, and reduces the amount of toxins and

their aspiration into healthy tissue. Krause[92] truly observed that of all the remedies proposed in the treatment of tuberculosis, only rest has stood the test of time. There are three ways of limiting the respiratory excursion of the thorax.

(*a*) **Pneumothorax.**—The pneumothorax treatment shows the great value of rest in pulmonary tuberculosis by the induction of collapse of the affected lung. It is not a substitute for sanatorium treatment, though it may become an important aid to it. It is preferably induced in unilateral disease, where in favourable cases it puts the lung more or less at rest. It is suitable only in a small number of cases—about 6 to 10 per cent. It is not indicated in early cases, and it should not be attempted in the advanced stage where both the lungs are likely to be involved. Repeated treatments are necessary, and the collapse should be kept up as long as possible. The prolonged period (two to three years or more) required and the great cost it entails (as it should be done for the most part in a sanatorium, where the patients can be watched and looked after) are serious objections to the treatment. Best results are obtained in those cases where a successful collapse can be secured.

When the induction of collapse fails on account of pleural adhesions, phrenicotomy and thoracoplasty may be called for. Every case of pneumothorax should be X-rayed not only to ascertain the character of the pneumothorax, but to watch the progress of the case and to guide in taking further steps. Pleurisy with effusion is a common complication. Bernard and Baron observed pleurisy complication in 60 per cent. of pneumothorax cases. There is also risk from air embolism, spontaneous pneumothorax with emphysema, extension of the disease to the opposite lung, etc. From the results available at present no definite conclusions can be drawn as to the indications and contra-indications for artificial pneumothorax treatment. As Dr. A. Adams[93] has observed, the surgical treatment of pulmonary tuberculosis has failed to fulfil the glowing promise of the enthusiasts who proclaimed its merits. Clive Riviere,[94] writing on the subject, says: 'I foresee a time when the conscientious phthisiologist will

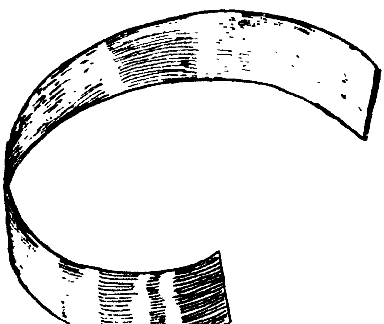
look upon this treatment as a curse, but a curse from which he cannot shake himself free.' The writer contends that if pulmonary tuberculosis is diagnosed early and treatment begun at once, it should not be necessary to subject the patient to the long weary course of collapse therapy or to the more painful ordeal of thoracoplasty.

(*b*) The method of external compression of the lung in pulmonary tuberculosis by mechanical means was in existence even before the development of collapse therapy. The use of 'lung splints' has been associated with the name of Dr. Dobell for more than forty years. In 1890 Dr. Stuart Tidey first practised external compression of the lower thorax by strapping the chest wall. Sewall and Swezey, of the National Jewish Hospital for Consumption, Colorado, made their first experiment by strapping to limit the movement of the upper ribs by encircling the chest for a width of some 3 inches with overlapping strips of adhesive plaster reaching high into the axillæ, and applying it over a light bandage. Later they substituted strips of 'herring-bone belting,' 3 to 3½ inches wide, and long enough to overlap some 5 inches when encircling the chest. Three buckles were sewn at one end, and strips of webbing (like suspender garter straps) sewn to the belt about 5 inches from the other end, and the belt held in place by a shoulder strap running through loops, one at the back and two in front, to prevent slipping down.

Dr. W. Levitt, of Endowood Sanatorium, Maryland, uses a plaster jacket for the upper part of the chest. First a stockinet jacket is put on the chest, the axillæ and scapulæ are padded, and strips of sheet wadding then applied round the chest, extending from the second to the first rib. Then plaster bandages (two rolls 4 inches wide and 5 yards long) applied by making one turn of the bandage around the chest while the patient is told to expire and hold his breath for a little while; a few more turns to cover from second to fifth rib are then made quickly, so as to get the smallest diameter of the chest and maximum amount of limitation without interfering with the comfort of the patient. The total weight is about ½ pound, and the plaster cast is worn from two to four

FIG. E.—DR. W. C. HOWELL'S THORACIC SPLINT.

(After Dr. Howell.)



One of the three springs.

To face page lv.

months. At first there may be a feeling of tightness round the chest and shortness of breath, which soon pass away.

W. C. Howell, of Colorado Springs, Colorado, has constructed a very useful splint made of ordinary plaster-of-Paris bandages for the front and back of the affected side, reaching not quite to the sternum in front nor the spines of the vertebræ behind. When the splint is about half made, and just strong enough to stand a moderate amount of pressure, three springs, each from 10 to 13 inches long, are placed over the splint, and over these are placed more layers of the plaster-of-Paris bandages to incorporate the

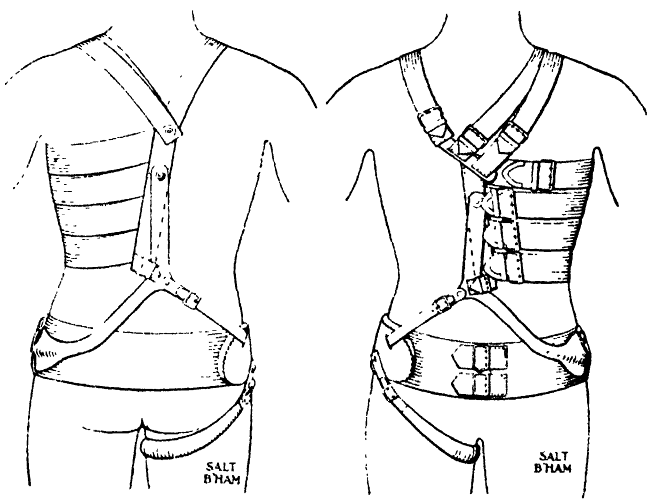


FIG. 1.—DR. STEWART'S LUNG SPLINT.

springs, cover the springs and fix them, and a 2-inch strip is removed from the axillary area to make two separate splints, as shown in the illustration. After drying an hour it can be removed, trimmed, and the edges smoothed. The patient is instructed to wear the appliance for only half an hour at a time for several times the first day. Each day he can wear it for a longer and longer period until it is worn twelve or more hours a day. He should always put it on before leaving the bed. It can be easily worn while the patient is in bed.

In this country Dr. H. S. Stewart has devised a splint made of webbing bands for the unilateral disease of the

lung. It is light in weight and suitably padded, so that it can be worn continuously, a light woollen garment being worn next to the skin. The limbs have free movement, and there is no vital impairment of the opposite lung.

Dr. R. C. Wingfield, of Brompton Hospital Sanatorium, Frimley, has brought out a splint consisting of an aluminium shoulderpiece covered with rubber, and lined by a rubber pneumatic bag which can be inflated to any desired pressure. The splint controls apical movement, is entirely unilateral in its action, and does not interfere with manual work or with the movement of the opposite lung.

Dr. Thomas Beasley, of Indianapolis, has designed a belt to encircle the lower portion of the chest, which, on account of a more extensive respiratory excursion, is easier to restrict than the more rigid and less expansive upper thorax. The belt is made of moleskin cloth 5 inches wide, and is adjustable by having a lace in front similar to that used in abdominal belts, and reinforced at the sides by pads 1 inch thick, and which, by exerting an adequate pressure, restricts the respiratory excursion. Dr. Beasley found the belt to be of benefit in acute and chronic pulmonary tuberculosis in which there is a great amount of moisture in the lungs, modifying the violence and frequency of cough, lessening the amount of sputum, and giving a degree of rest for the infected parts.

In this country Dr. Tidey,[95] like Dr. Beasley, believes in applying pressure round the lower part of the chest, and gives an interesting account of the rationale of such a procedure. He finds that pulmonary lesions do not heal, because they are exposed to the continuous pull on their periphery of intrathoracic suction—a pull of 14·7 pounds to the square inch—which acts in opposition to the healing process, while the rhythmical movements of respiration tend further to oppose tissue repair; that relaxation of this peripheral pull or tension is the factor which plays the prominent part in the healing of pulmonary lesions, and that compression of the lung at the base brings that factor into action; and that by constricting the lower part of the

thoracic cavity the lung is thrust in an upward direction and relaxes the tension on the diseased areas, and so enables them to heal. Therefore he recommends bilateral compression of the base of the lung by means of a broad bandage or corset, which is somewhat similar to the one advocated by Dr. Beasley.

In 1922 the writer began using external compression of the lung by means of splints made to encircle the upper part of the chest, but lately he has found better results by applying pressure at the base. He agrees with Dr. Tidey that by compressing the lower portion of the thoracic cavity the diseased part of the lung gets the maximum amount of relaxation, which is so essential to its healing. He found that such external pressure at the base is very beneficial in early cases of pulmonary tuberculosis in reducing fever, violent cough, and expectoration.

He has devised a thoracic belt to compress the lower portion of the chest, which is simple in design, and made after the pattern of abdominal belts or surgical corsets. It is 6 inches deep, suitably corded, and boned at the sides, and has lacing in the front of the centre, so that it can be gradually tightened to any degree desired, with shoulder straps to prevent it from slipping down. It has two horsehair stuffed pads passing well round, one on each side, to give an even continuous pressure over the lower ribs. As in the case of Dr. Howell's splint, the patient should wear the belt for an hour or two the first day, and gradually increase the period in succeeding days till it can be worn for many hours a day. It can also be worn at night. The belt has been made to the author's instructions by Salt and Sons, Birmingham (see Fig. G).

(*c*) In the third way, which may be used in conjunction with either of the previous methods, the power of will is brought into play in controlling the respiratory movements. It is well known that slow-breathing animals, like the horse, are least susceptible to tuberculosis, while the rapid-breathing rabbits and guinea-pigs are most susceptible to the disease. The patient is taught to keep his lung still, breathe slowly,

and restrict his respiration as much as possible. It is wonderful what practice and habit can do in helping to diminish the respiratory movement of the lung. The writer found this method an important aid in the treatment of some cases of active disease with troublesome cough, especially among Indians, who are adepts in controlling the rate of breathing and circulation by the exercise of their will-power. Slowing the respiratory movement helps a great deal in lessening cough, bringing down the temperature, and thus helping Nature to proceed with the healing process in the lung.

We may not understand the exact mechanism by which the above measures act in the treatment of pulmonary tuberculosis. Of course, complete rest of the lung is not possible, as lungs are organs that never rest, but are in constant motion. But complete immobilization of the lungs is not necessary, as even partial immobilization has yielded good clinical results in pulmonary disease. In the muscular rigidity of the chest that follows pulmonary tuberculosis Nature enforces only partial rest. Both internal and external compression of the chest help to lessen cough and expectoration, check the flow of toxins and their dissemination into healthy parts, and relax the tension of the peripheral pull on the diseased areas, thus enabling them to heal and bring about a general improvement. The very compression, internal or external, continued for awhile causes an impression upon the mind, which becomes a factor in slowing the breathing and limiting the movement of the chest. Pneumothorax perhaps ensures a more complete collapse of the lung than any of the external appliances. But it has its dangers and disadvantages. Its treatment is limited to a small number of unilateral cases, and where there is an absence of pleural adhesions, and the collapse will have to be maintained at frequent intervals and for a long period of time. In the case of pleural adhesions further operative procedures are involved, which carry a certain amount of danger. Whereas external compression is simple and inexpensive, and can be applied by the attending physician at home and

in a larger number of cases, there is no danger or risk of the disease invading the healthy lung, and it can be used when pneumothorax is inapplicable or unacceptable to the patient. As Dr. Tidey says, the relaxation of the peripheral pull on diseased areas can be effected without collapse of the lung, and that external compression is fundamentally the more rational method because it seconds the natural processes of repair, whereas internal compression is opposed to them. Therefore the writer would strongly suggest that this simple method should be tried first before deciding to submit the patient to a prolonged and more serious treatment of pneumothorax and thoracoplasty.

Heliotherapy.

After the open air its companion, sunlight, has found a place in the treatment of pulmonary tuberculosis. The way has been opened by the researches of Finsen and Saugman in Denmark, Bernhard in Switzerland, and Rollier at Leysin, whose successful treatment of surgical tuberculosis is well known to the medical profession. In this country excellent results from light treatment have been obtained by Dr. J. H. Sequeira in lupus and other skin affections at the London Hospital, and by Sir Henry Gauvain in bone and joint tuberculosis at Alton and Hayling Island. The Westerner, living under a pall of smoke and darkness a great part of the year, is apparently at a disadvantage when compared with the children of the sun in Oriental countries. And yet tuberculosis is widely prevalent in countries like India and Switzerland, where the people enjoy a large amount of sunshine. For some time ultra-violet radiation has been employed with great benefit in tuberculosis of bones and joints, glandular tuberculosis, tubercular peritonitis, various skin affections, in lumbago and sciatica, in rickets and tetany, and recently in pulmonary and laryngeal tuberculosis.

Heliotherapy does not seem to have any specific action on tuberculosis, though medical opinion is divided on the point, some like Reyn and others saying it has, while Petersen, Bachmeister, etc., deny it. Its therapeutic effects depend a

great deal on its action on the skin, which offers a vehicle both for eliminating poisons and excretions from within and for absorbing substances like oxygen and light rays from without. Like other non-specific reactions, sunlight acts like a stimulant, causing hyperæmia and a mild focal reaction, thus accelerating the absorption of the sun's rays. Too much light and sunshine, especially in the summer, may irritate the skin and provoke skin affections. Prolonged exposure produces a severe febrile condition, a rise of temperature, increased pulse-rate, and general malaise, like the tuberculin reaction. But when the reaction of the skin is regulated by time exposure and controlled by the production of erythema, it stimulates metabolism, facilitates the excretion of CO_2 and other deleterious substances, and the absorption of exudates, as in pleurisy with effusion, increases hæmoglobin and lymphocytes, and acts like a tonic to both mind and body, producing a sense of general well-being and exhilaration. Thus, in a general way we can account for its beneficial effect on tuberculosis without assuming any specific or bactericidal action on tubercle bacilli. Also, as Petersen suggests, the relative richness of the epidermal tissues in lipases which, when mobilized after heliotherapy, might theoretically prove of decided value in resistance to tuberculosis.

No artificial light therapy can take the place of solar energy, as no lamp can give a spectrum exactly like that of the sun. Light baths taken in a dark room, where one is shut up without efficient ventilation and breathing the vitiated air of a number of people, is not so enjoyable or likely to be as beneficial as an actual sun bath taken in the open, surrounded with the 'sun-ozonized purified air.' The sun bath should be taken in the cool of the morning sun and the time gradually increased, care being taken to protect the head and neck. Midday sun is injurious both for surgical and pulmonary tuberculosis. The dark-skinned people require longer exposure than the fair-skinned. Contrary to the general prevailing opinion, a large percentage of ultra-violet rays (as demonstrated to the writer by Dr. Deck) does

pass through glass of considerable thickness, and quite easily through ordinary window glass.

An erythemic effect on the skin is necessary for the light treatment to produce any beneficial effect. Bach's[96] statement that 'a lamp that produces no skin erythema in a moderate period of time is therapeutically worthless' is

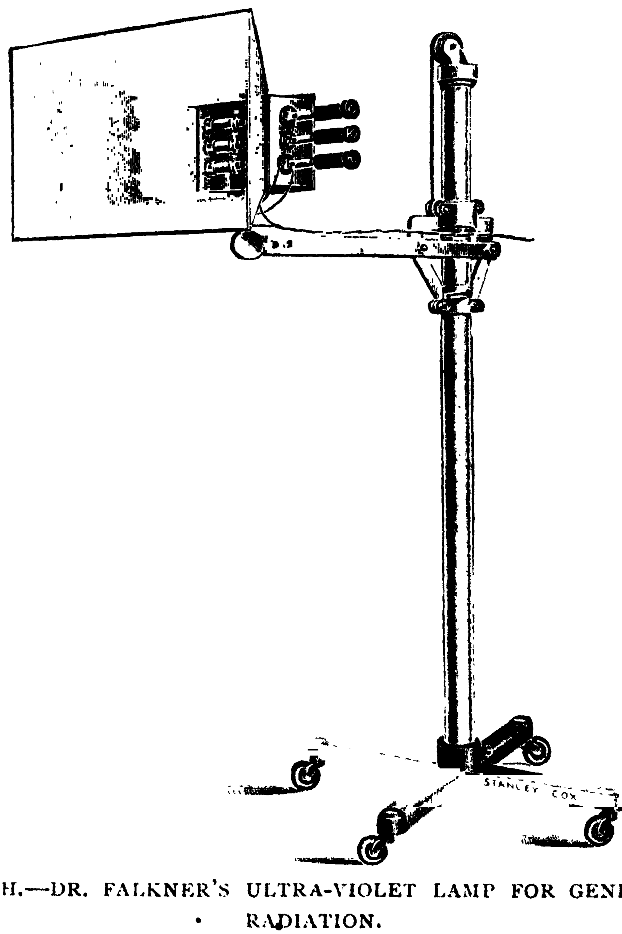


FIG. H.—DR. FALKNER'S ULTRA-VIOLET LAMP FOR GENERAL RADIATION.

probably true to a great extent. For erythema as a result of hyperæmia helps to facilitate the absorption of ultra-violet rays. Reyn aims to produce erythema, and is able to give larger doses after pigmentation. For this reason ultra-violet rays, when accompanied with luminous red rays, increase the energy of the actinic rays and yield better

results. And since the sun's rays exhibit a continuous spectrum and contain the greatest number of blue, violet, and ultra-violet rays of the greatest possible wave length with heat rays, the sun bath has a great advantage over any artificial light bath.

In artificial light the types of lamps generally used are various kinds of carbon arc lamp, mercury quartz lamp, and tungsten arc lamp. Dr. Strandberg considers that the carbon arc lamp approximates most nearly to sunlight. But carbon arc lamps themselves differ widely, though all of them contain a continuous spectrum. The writer, using the tungsten arc lamp, has obtained good results in pleurisy, enlarged cervical glands, tubercular peritonitis, and early pulmonary tuberculosis without any fever, and during convalescence. In giving light treatment it is well to remember one or two points. (*a*) The extent of the benefit of the light treatment does not lie so much on the intensity or the amount of sunshine, or the kind of lamp used, as in the varying capacity of the individual to make use of the insolation. Just as in regard to food it is not the quantity we eat, but what we are able to digest and assimilate, that nourishes the system, so the effect of light radiation depends upon the individual power of response, as Sir Henry Gauvain[97] has clearly shown. In fact, bright sunshine, such as the midday sun, and excessive stimulation, like hyperalimentation, would do more harm than good. (*b*) This power of response of the individual depends upon the condition of his vital force at the time of insolation. As we noticed with regard to resistance, the same law holds good here also. Nature has her times of repose and activity, her seasons when she is at rest or alive with energy. We must woo Nature and understand her rhythmic phase of resting and working periods to get the full benefit of light treatment. As Sir Henry Gauvain pointed out, there are seasonal and diurnal variations in response to light stimuli in the same individual. As in resistance, his response should be more active in the spring and early summer when Nature everywhere is so full of life and activity. (*c*) This response can be stimulated by the varia-

tions of temperature and atmospheric conditions, such as cool air, sunny or cloudy weather, etc. Just as we noticed (p. 302) that a variable climate is in general much more healthful than a uniform climate, so we found that exposure of a patient to a uniform degree of sunshine day after day does not stimulate or benefit the system so well as exposure to the changing conditions of light and shade, to the cloud effects, and to changes in temperature and moisture, which bring about an alteration in the stimulus of light and air. In fact, we prefer the light cloudy days of the Indian sun and the days after a shower of rain. The morning light is very valuable for treatment, as cool air tones up the skin and facilitates the absorption of light rays. Also the treatment should be graded according to the vital capacity of the patient, whether he is young or old, weak or strong. Clinical experience can help us to gauge the amount of exposure required by the individual and his capacity to respond to the treatment.

We do not know the actual mode of action of light baths nor all the ways by which ultra-violet rays bring about physiological and therapeutic effects in diseased conditions. Like all new methods of treatment, there is a tendency to exaggerate its curative value in pulmonary tuberculosis. But we are sure that it is Nature's remedy, and that with fresh air it will find an assured place among the agents that are used for the arrest of the disease.

Laryngeal Tuberculosis.—Dr. Strandberg,[96] of the Finsen Institute, Copenhagen, speaks highly of heliotherapy and artificial light in the treatment of laryngeal tuberculosis. He has obtained a cure in 50 per cent. of cases. He says that it is possible to bring about a clinical cure by means of general light baths alone, though the period of treatment can be considerably shortened by employing local treatment at the same time. When there are no complications he gives treatment, beginning with 25 minutes from a carbon arc lamp (which approximates most nearly to sunlight) for adults, and increasing 10 to 15 minutes every alternate day till the full period of 2½ hours is reached. No attention

should be paid to slight rises of temperature. For local treatment, either direct reflection of sun's rays on the laryngoscopic mirror, the patient facing the sun, or reflected light from a carbon arc lamp can be used. After every light bath the patients are given a tepid shower bath. Contra-indications for the use of light baths are: severe forms of heart disease, arterial sclerosis, and non-tuberculous nephritis. Greene[99] says that electro-cautery is destined to become the chief therapeutic measure in the treatment of laryngeal tuberculosis. Sir St. Clair Thomson[100] relies chiefly on voice rest, Muthu or Yeo's inhaler, galvano-cautery when necessary, and pneumothorax. Relating the beneficial results of pneumothorax in some of his cases at Midhurst Sanatorium, he says that the presence of tuberculosis in the larynx is no contra-indication to pneumothorax. On the contrary, it may speedily effect a cure or render more promising the addition of galvano-cautery or other treatment, and that the larynx can be cured by this measure, even although bacilli may continue to be present in the sputum and mischief detectable in the chest. The writer has been using for years silence and inhalation treatment in early cases (p. 312), and lately heliotherapy with great benefit.

Conjugal Tuberculosis.

If almost everyone is infected in childhood with tuberculosis in civilized countries, it is natural to expect by the law of chance association that a percentage of married people should both be tuberculous. But it is surprising how actually small this percentage is. Fishberg[101] found that out of 161 wives of tuberculous husbands, 4, or 2·5 per cent., were tuberculous. Tillisch,[102] out of 1,152, 85, or 7·4 per cent., of the consorts were tuberculous. De Besch and Jorgensen note that in 742 marriages both parties suffered from tuberculosis in 30 instances, or 5·25 per cent. Ward Brinton,[103] Philadelphia, found that among 814 married patients with tuberculous disease a history of tuberculosis in the consorts was obtained in 54 instances, or 6⅔ per cent. Deducting the

cases in which there was a family history of 17, it leaves a balance of 37 cases, or $4\frac{1}{2}$ per cent. So that conjugal tuberculosis seems to be rare, as was previously pointed out. The death-rate from phthisis of the spouses of tuberculous persons varies little from that of the general population of corresponding age.

Pregnancy and Tuberculosis.

In confirmation of the views already expressed on this subject (p. 353) we may quote H. Forssner[104] again. His first study, published in 1917, led him to conclude that proof was lacking of the generally accepted axiom concerning the baneful effect of pregnancy in pulmonary tuberculosis. He has recently been able to carry out more extensive investigations with the aid and co-operation of the Swedish National Anti-tuberculosis League. A comparison of statistics, showing the pulmonary condition after a period of one or two years (*a*) in women who have never borne children, and (*b*) in those who have borne children during or immediately preceding those two years, shows nothing in favour of the former group. All the statistics examined by the author go to show that the so-called deleterious influence of pregnancy upon tuberculosis is a pure myth, and that pregnancy going to term is no more dangerous for a woman in the early stages of tuberculosis than it is for a healthy woman.[105] In the statistics of Pankow and Kupferle[106] of Kronig's clinic, no proof has been furnished that abortion checks the active evolution of the tuberculous process. The greatest fallacy lies in attributing to the pregnancy itself any exacerbation of the disease during the time of gestation. Social status and financial resources of the patient most likely govern the situation. Tuberculosis may be aggravated by the poverty condition of the mother and by her worry and anxiety. For her pregnancy becomes an additional strain to the ordinary household duties, and when poverty and worry are added to these, it is only natural to infer that, if she has no means to take rest, she may overdraw her reserve powers and be in danger of succumbing to the added strain. Hence the

social and economic conditions greatly control this question. Interruption of pregnancy usually does no good. In early or quiescent or arrested cases it is not necessary, and in advanced cases with active disease it is most inadvisable, as there is a danger of aggravating the disease. If it is done at all, it should be done before the third month of pregnancy. The writer has found that sanatorium treatment, when begun as soon as a tuberculous patient is found to be pregnant, and continued for four or five months, generally saves both mother and child. All the mothers thus treated in our sanatorium have since delivered strong and healthy children, and have continued to be healthy for the number of years they have been kept under observation.

4. THE ENVIRONMENTAL FACTORS OF TUBERCULOSIS.

'We consider tuberculosis a nutritional disease.'—VON PIRQUET.

'The cure of tuberculosis is a question of nutrition.'—SIR WILLIAM OSLER.

'The nation's health should be the primary concern of every great statesman.'—LORD BEACONSFIELD.

The study of the problems of tuberculosis brings one face to face with two schools of thought. The specific school believes in infection, injection, and preventive inoculation; and the social and economic school in environment, endowment, and social and economic improvement in the cause and prevention of tuberculosis. We have already seen that the experimental observations and results of the first school have left us to a large extent in the realm of hypotheses and uncertainty, and have not led to any specific cure and immunization in tuberculosis. The second school bases its claim on the evidence of practical results obtained from all parts of the world, showing the intimate relation between the social and economic improvement and decline in the incidence and mortality of tuberculosis.

Dr. Charles F. Bolduan, of the New York Health Service, observing that 'as many of our public-health problems have failed of solution when attacked from the standpoint of the

germ as the cause,' quotes the following principles as given by Grotjahn in his *Social Pathology*:

(*a*) The social and economic conditions create or favour the disposition to disease.

(*b*) They bring with them the conditions which are necessary for the disease to develop.

(*c*) They constitute the means of transmission of the disease.

(*d*) They influence the cause of the disease.

The social and economic school formulates its arguments and general principles as follows:

1. It is not infection, but lowered vitality and resistance, that is the most important factor in the development of tuberculosis.

2. This lowered vitality is due to environmental causes, such as climatic, industrial, hygienic, and economic, and especially due to faulty feeding and lowered nutrition, coupled with strenuous life and mental stress.

3. The individual or the nation that is best fed and keeps itself most fit by personal and communal hygiene is the one that is best able to ward off tuberculosis and acquire the highest immunity against the disease.

4. Therefore, for the most successful crusade against tuberculosis, we should endeavour to concentrate our best efforts in improving man himself in his social, hygienic, and economic environment.

Tuberculosis is a living problem. Only life can interpret life. It is not by the intensive work in the laboratory, but by the patient study of the living conditions of the people, that we can unravel the complex problems of tuberculosis. Man's home environment, his manner of living, his housing condition, his wants and cares, habits and temperament, the work he does, the wages he earns, the air he breathes, the food he eats, the rest he takes—it is these living factors that control the prevalence of tuberculosis.

Tuberculosis is related to various environmental factors. To consider briefly: **It is related to climatic conditions.** Meteorological conditions and atmospheric humidity play their

part in influencing tuberculosis, as Sir Leonard Rogers has shown they also do in plague, cholera, and malaria. Constant exposure to strong rain-bearing winds or to dampness of soil tends to lower the resistance of the body and predispose to tuberculosis, especially in those individuals whose vitality is already low. It has already been pointed out that the climatic and seasonal variations affect the susceptibility and mortality of experimental animals. For the most part the recent papers on seasonal variation in susceptibility concern themselves primarily with diet deficiencies. There seems to be a seasonal variation in the mortality of tuberculosis in different countries. While the four maritime towns of India—Bombay, Calcutta, Madras, and Rangoon—show a pronounced crest in tuberculosis mortality from May to September, in London and Germany the crest is in February and March. In Vienna it is from April to May; and New York exhibits two crests—one from February to March, and a higher one from May to June.[106a] The tropical heat has a debilitating effect, and renders the disease more fatal among the Indian population. Though mountain ranges and high tablelands have a bracing and invigorating climate, their good effects can be neutralized by bad sanitary and economic conditions, as seen among the Mexicans, who, though living at an altitude of 7,000 feet, yet have a high incidence of tuberculosis.

More important than climate are industrial factors. It is well known that tailoring, printing, and shoemaking are 'phthisis-ridden' industries, and that lead and tin mining, ganister mining, and cutlery manufacturing take a heavy toll among the workers. While the highest death-rates are found in the industrial group, the lowest is found among those whose economic well-being is highest. Even among the industrial classes high wages cause a lower death-rate in tuberculosis.

Next to industrial factors are a group comprising **want of fresh air and sunlight, overcrowding, slums, bad housing**—one-roomed tenements where families with children are herded together and living unwholesome lives. For

instance, according to the report of two surveyors (Mrs. Barclay and Miss Perry), some of the worst cases of overcrowding in London are, indeed, not in the East End, but in wealthy Westminster, within a short walk of Buckingham Palace, in the heart of the British Empire. Glasgow in 1911 had 32,742 houses of one room, accommodating 104,621 people. Sixty per cent. of Glasgow houses consist of one and two apartments. In New York there is fourteen times as much tuberculosis in crowded districts of the city as around Central Park. Whether it be in America, England, Scotland, Australia, or India, the same principle holds good—viz., the incidence and death-rate of tuberculosis are correlated with the density of the population.

DEATH-RATE PER 100,000 FROM TUBERCULOSIS.

	Greenock, 1913.	Glasgow, 1913.	Edinburgh, 1910-12.
One-roomed house ...	222	240	225
Two-roomed house ...	179	180	146
Three-roomed house	106	120	111
Four-roomed house...	87	70	56

While the incidence of the disease is slight in richer-class residential quarters, it is comparatively high in poor, squalid, and congested areas. The tuberculosis mortality in healthy Hampstead was 52 among a population of 88,040, but in poor and congested Finsbury it was 110—more than double—with a little smaller population of 77,560.

According to the report on the census of England and Wales, 1921, England is the most crowded nation, 80 per cent. of the population living in town areas. Overcrowding has increased, and house shortage is acutely felt by a large number of middle and working classes. The effect of bad housing is seen from the annual report, 1925, of Sir George Newman, Chief Medical Officer of the Board of Education, where he says: 'Year by year there is a steady and undiminishing stream of defect or physical impairment of the entrants coming into schools at five years of age.

There is also a steady burden of disease in older children, apparently never lessening, which requires medical or surgical treatment. All too often we are trying to rear a healthy race which has been born in slums, and nurture it without the necessary amenities of favourable home surroundings. In addition to a lack of house accommodation, we have to reacquire the supreme arts of maternity and domestic nurture. Our industrial success of a century and more is being paid for in some degree of loss of humanity.'

Still more important than want of fresh air and overcrowding come a group of factors, which consist of **poverty and want, insufficient food and faulty feeding, impaired nutrition and malnutrition.** It is very difficult to separate the environmental factors, and assess to each its relative value and share in the causation of tuberculosis. Poor wages, unemployment, privation, want, and underfeeding are responsible for much of the poverty, overcrowding, and slum conditions, two- or one-roomed housing, which bring in their turn misery and wretchedness, intemperance and inefficiency. Or industrial employment, fatigue, physical and mental overstrain, industrial drinking, and loss of vital force may go together. So all these various factors form a vicious circle, each enhancing the evil effects of the other, and all leading to loss of resistance, ill-health, predisposition to disease, and leaving an indelible mark upon the race for generations. This is why tuberculosis claims its greatest number of sufferers from the ranks of the poor.

But inadequate and faulty feeding and poor nutrition form the basic factor in undermining vitality and opening the door to tuberculosis. On the other hand, nourishing food and sound nutrition and health go far towards offsetting the evil effects of overcrowding and bad hygienic conditions. The problem of tuberculosis is the problem of nutrition, which in turn depends upon the wage-earnings of the individual. Dr. R. J. Ewart[107] found that the rise in the consumption of food and increase in wages in the country were closely allied to a corresponding fall in the death-rate of tuberculosis. In fact, when we study the social and

economic conditions of different countries, we are struck by the fact that the people who are best nourished and enjoy the most wholesome and hygienic surroundings show the lowest incidence and mortality from tuberculosis.

Countries like Great Britain, Denmark, America, Australia, and New Zealand have a higher standard of living and hygienic conditions, and a lower death-rate from tuberculosis, than countries like France, India, China, and Japan. France shows a higher incidence and mortality from tuberculosis than England, because the standard of health of her people, her sanitary and public health services are seriously below those of England. M. Landry, speaking in the French Chamber last year, laid emphasis on the low standard of public health in France, the lowness of salaries and smallness of earnings of her people, the want of precaution to protect the water supply, the negligence in carrying out the drainage system in the building sites of the suburbs of Paris, lack of providing curative and preventive measures, and want of education of the agricultural workers who form the great bulk of her population. Side by side with these evils there is a great increase of alcoholism in France. The result is that diseases like typhoid, measles, and diphtheria are very prevalent in that country; infant mortality is high, the death-rate among babies less than a year old being more than a tenth of the total population; the ravages of consumption are terrible, France having the highest general death-rate and highest tuberculosis mortality among civilized nations.

While the economic and hygienic conditions are higher in England than in France, Australia and New Zealand exhibit a higher standard of living than Great Britain or any other country in Europe.

Mr. James Stewart, after an extensive tour, says that Australia has houses for all her people; it is a land without tenements, and 50 per cent. of the workers live in four- and five-roomed houses, which are of bungalow type, and are spread out in the ratio of four and a half to the acre. The basic minimum wage of unskilled workers in five out of six

states is £4 to £5, in Tasmania it is £4, and many workers earn more, and miners can earn £12. Apart from Sydney, there are no slums or down-at-heel poverty, and in all his tour he did not see one rickety or stunted child; all are well cared for. No wonder that while in 1919 England and Wales showed a tuberculosis mortality of 97 per 100,000, in Australia and New Zealand it was only 54 per 100,000. Turning to America, we find that all over the country there is a remarkable improvement in the status of the great mass of her people, as seen by the better conditions under which they work, the shortening of the hours of labour, the increase of wages, the great saving of their earnings, and prosperity. Professor Irving Fisher, of Yale, declares that 6,000,000,000 dollars have been added annually to the national wealth of America. America has also broadened her campaign against tuberculosis by providing all kinds of measures to improve the health of the child, the citizen, and the community as a whole, and to raise the level of their resistance. Consequently, her death-rate from tuberculosis stands fifth in the list of all causes of mortality. In 1900 her death-rate was 164·7 per 100,000, which was reduced to 94·2 in 1921; whereas in England it stood at 145 in 1911, and came down to 112 per 100,000 in 1921—*i.e.*, America, with a greater mortality to begin with, has outstripped England by bringing about a greater reduction within ten years. Now the United States enjoys the place of prominence among all nations for the most rapid fall in tuberculosis mortality from 202 in 1900 to 90·6 in 1924.[107a]

So everywhere the world witnesses to the truth that, in proportion as the nations stand high in their economic prosperity and well-being of their people, have they reduced the incidence and mortality of tuberculosis.

On the other hand, what stronger or more conclusive proof can be brought forward to prove that nutrition, not infection, controls tuberculosis than the late world war, when the disease flared up in all the affected countries, and its mortality in places like Germany, Vienna, etc., rose to nearly double, and in Warsaw more than double (from 303

in 1913 it rose to 840 per 100,000 in 1917) the rate for 1913 from scarcity of food, underfeeding, and malnutrition? Even now Austria, whose economic condition is bad and distressing, has a tuberculosis death-rate of 227 per 100,000, which is in strong contrast with Australia and New Zealand, where, with little poverty to contend with, their record of tuberculosis mortality is only 50 per 100,000. Again, to take another instance from the teeming millions of India, whose economic condition is dependent primarily upon agriculture, we find that a favourable monsoon and rainfall result in a good harvest, a plentiful food supply, and improved prosperity, which is followed by a higher birth-rate and lower death-rate. Whereas a poor monsoon and low rainfall mean a poor harvest; scarcity of food, culminating in famine in some parts; a diminished birth-rate and increased mortality, of which tuberculosis and infantile mortality take their full share—which shows that the health and prosperity of the Indian people are closely associated with their economic condition.

So all these facts (and many more could be added if space would permit), gathered from all parts of the world, lead unmistakably to the conclusion that the improved social and economic well-being of a people is the only sure and certain means of promoting national health and bringing about a reduction and prevention of tuberculosis.

Diet and Disease.—This brings us to consider the question of diet in relation to disease. McCollum[108] has ably shown that among all the hygienic factors which influence the welfare of human beings or the lower animals, the nutritional factor stands first in importance. A well-balanced diet and sound nutrition greatly contribute to the physical vigour, health, and well-being of individuals and races. Whereas a poorly nourished population manifests an inferiority of physical development, instability of the nervous system, a lack of recuperative power and endurance, and a want of resistance to disease like tuberculosis. Campbell found that among the poorer classes in the slums of English cities the family never passes beyond the third

generation. The advance of Western civilization has altered the living conditions and dietary habits of both European and non-European races. The diet of a large majority of the lower wage-earning classes, which chiefly consists of white bread, margarine, tea, polished rice, and jam, is seriously deficient in animal proteins and animal fat, and contains an excess of cereal. Wholemeal bread, fresh milk, and green food are seldom taken by them, which makes their vitamin deficiency still more conspicuous. Even the diet of the middle class is faulty, and is deficient in nutritive value. The modern roller-milling process, by removing the germ and the bran from the flour, has deprived the bread of some of the protein, inorganic salts (such as phosphorus, calcium, potassium, sodium, chlorine, and iron), and A and B vitamins. No other food can adequately replace the deficiency of vitamin B in white bread, which forms 70 to 80 per cent. of diet of the people. The civilized man, eating refined and white foods, soft and pappy foods, tinned and frozen foods, devitalized and adulterated foods—foods deficient in protein of biologic value, mineral elements, and vitamins—eventually comes to suffer from lack of vigour and resistance, from physical defects and malnutrition, which sooner or later culminate in various diseased conditions. When we consider that even small deviations from natural food may cause profound endocrine disturbance and changes in the finer structures of living tissue, and in chemical reactions and metabolism, we can understand why most people, both children and adults, in civilized countries suffer from physical and mental ill-health.

Of course, an ideal diet is one which chiefly consists of a little meat or fish, wholemeal bread and fresh butter, milk (adults, ½ pint; and children and invalids, 1 pint) and eggs, green vegetables, cheese, salads, and fruit. Since a large number of the wage-earning classes cannot afford to live on such a diet, they must suffer from a chronic shortage of those vital elements essential to normal nutrition and health. Under faulty nutrition the machinery of the body tends to break down frequently. Malnutrition or marasmus

in infants is a condition due to a deficiency of fat-soluble vitamins.[109]

Besides the well-recognized deficiency diseases, such as rickets, beri-beri, pellagra, keratomalacia, scurvy, œdema, and gastro-intestinal disturbances, there are many ill-defined conditions of ill-health and border-line cases of malnutrition, interruption of growth, irritability and nervousness, conjunctivitis, night blindness and other affections of the eye, dental decay, adenoids, enlarged glands, and many other affections which are due to food and vitamin deficiencies and disordered nutrition. And when prolonged inadequate feeding and defective nutrition go hand in hand with slums and overcrowding and bad hygienic conditions, the prevalence of physical defects and degeneration becomes profound and seriously threatens the welfare of the individual and the nation. Hence Sir George Newman deplores that a million children of school age are physically and mentally defective, and are suffering from diseases of the eye, ear, throat, skin, heart, lymphatic glands, and tuberculosis, and are so diseased as to be unable to derive reasonable benefit from the ordinary form of education which the State provides. A properly constituted diet, including an adequate supply of fat-soluble vitamin, will practically eliminate rickets, improve the condition of teeth, lessen the infant mortality from malnutrition, diarrhœa, and respiratory infections, and generally raise the standard of physique and health of children.

To illustrate the good effects of healthy and wholesome surroundings on the physique of children, we have but to compare the children living in a place like the Bournville village with those reared in the city of Birmingham, not far from Bournville:

Death-rate per 1,000 (average for five years ending 1924): Bournville, 7·4; Birmingham, 11·7; England and Wales, 12·2.

Infantile mortality per 1,000 live births (average for five years ending 1924): Bournville, 53·4; Birmingham, 81·4; England and Wales, 76·8.

Comparison of Bournville Children with those in Poor City Area.

	Boys.				Boys.			
Age (years) ...	6	8	10	12	6	8	10	12
	Weight.				Height.			
	Lbs.	Lbs.	Lbs.	Lbs.	Inches.	Inches.	Inches.	Inches.
Bournville ...	45·0	52·9	61·6	71·8	44·1	48·3	51·9	54·8
Floodgate Street, Birmingham	39·0	47·8	56·1	63·2	41·9	46·2	49·6	52·3
	Girls.				Girls.			
Bournville ...	43·5	50·3	62·1	74·7	44·2	48·6	52·1	56·0
Floodgate Street, Birmingham	39·4	45·6	53·9	65·7	41·7	44·8	48·1	53·1

On the other hand, physical defects caused by bad environment affect the mental side of life as well. There are men with wide experience who hold that much of the delinquency among children and criminal tendencies among adults is due to physical defects, which might have been prevented easily enough in the years of early childhood. Dr. Harvey Sutton,[110] speaking at the Australasian Medical Congress this year, associated delinquency in New South Wales with all forms of defects—such as defects of the nose, throat, and ear—in the child population. In this twentieth century we are beginning to realize that as inadequate and ill-balanced food is a cause of ill-health, disease in turn is a cause of crime.

Diet and Tuberculosis.—Diet and nutrition pre-eminently influence tuberculosis more than any other causal factor. According to Sir William Osler, the cure of tuberculosis is a question of nutrition. Tuberculosis can be truly called a deficiency disease. The deficiency in the feeding lowers resistance, and sows the seeds of the disease in the early years of childhood. Faulty dietary habits to a great extent lead to susceptibility to tuberculosis. On the other hand,

there is no more effective therapeutic measure than proper feeding to raise the recuperative power of a tuberculous patient. The changed dietary habits are responsible for the onward march of tuberculosis in every country that has come under the influence of Western civilization. Not only in England, but in remote parts, like the Highlands of Scotland, where diet in former times consisted of oatmeal porridge, mutton broth, eggs and milk, etc., the people have for the most part taken to tea, jam, and white bread, and are suffering in a large number from tuberculosis through lowered resistance produced by defective dietary. Also in far-off countries like Labrador and Newfoundland, where the people have adopted the food and habits of Western civilization, such as the fisherfolk of Labrador and Newfoundland, Eskimos, Icelanders and Lapps, Negroes and American Indians; Oriental races in India, China, and Japan, and other lands, whose staple diet of polished rice is poor in protein and vitamins, they are suffering from social evils and tuberculosis in a more aggravated form than the European races. Appleton[111] points out that the men of Labrador and Newfoundland who have discarded their primitive diet (and kept free from tuberculosis), and have taken to refined and tinned foods, margarine and tea, suffer greatly from tuberculosis, although they spend half the year out of doors in a vigorous climate, with strong winds blowing all through the winter which keep their houses well ventilated. She therefore suggests that the faulty diet is the predisposing cause rather than unhygienic housing.

We find the same influence of diet in regard to animals. The question of tuberculosis in cows is a matter of diet and nutrition. We have been treating a symptom instead of dealing with the direct cause of tuberculosis among cows. Having a farm of his own, the writer can endorse Dr. M. J. Rowlands[112] when he says that the trouble is not so much due to infection and unhygienic conditions as to the lowered resistance of the dairy cow to tuberculosis as the result of unnatural feeding. In the first place, we feed them with patent foods and oil-cakes which are devoid of vitamins

which are essential for growth and development. Next, by over-milking them we exhaust their bodies and drain them of their vitamin content. Then we undermine the health of the calves by depriving them of their mothers' milk, and rear them on artificial foods which are deficient in vitamin A. Such a vitaminless food must in the end lead to tuberculosis. Dr. Rowlands has taken over herds of tuberculous cattle, and has brought the disease to a standstill by feeding them on the natural green food on which Nature intended them to be fed.

The feeding experiments of Mellanby, McCarrison, Drummond, McCollum, Cramer, and Kingsbury[113] have shown that diets that are deficient in vitamin A tend to lower resistance to bacterial infection and increase the susceptibility to broncho-pneumonia and catarrhal and inflammatory conditions of the respiratory and alimentary tract, and that this vitamin alone confers an increased power of resistance to lung infection. McCarrison has described the frequency of a catarrhal condition of the intestine, especially in the form of colitis in animals whose diet was deficient in vitamine B. Clinically, chronic catarrh of the respiratory passages of children, tendency to broncho-pneumonia, rickets, attacks of diarrhœa, and later enlarged tonsils, are intimately related. Rickety children are peculiarly liable to catarrhs, bronchitis, and broncho-pneumonia. The symptoms of the pretuberculous child, such as decayed teeth, enlarged glands, adenoids, underweight, nervousness, and irritability and malnutrition—symptoms which the older writers attributed to a scrofulous diathesis—can be explained on the basis of bad feeding, lack of fresh air and fat-soluble vitamins.

In such a poor dietetic environment two sets of changes take place in the organism: (*a*) Nutrition suffers, the soil is impoverished, vital functions are disturbed, and endocrine organs are deranged. (*b*) With lowered resistance the saprophytic organisms that have entered through milk, butter, etc., or those lodged in carious teeth, become virulent, and catarrhal and inflammatory conditions develop. McCollum[114] observes that animals restricted to deficient

diets term.nate in lung affections caused by a streptothrix. And tubercle bacillus, like other acid-fast organisms, is derived from a streptothrix. When a mother rat is fed on a faulty diet, especially a diet poor in protein, she destroys her young ones soon after birth; so when impaired nutrition or malnutrition is followed by defective condition of the blood and imperfect formation of proteins, Nature tries to destroy and build anew from the old protein fragments.

Wolff-Eisner[114a] emphasizes the relation that exists between the diet and exudative diathesis, defining this latter condition as due to the absorption of proteins and protein fragments insufficiently degraded in the intestinal tract—*i.e.*, a protein sensitization—and associates exudative diathesis with scrofula, which is not only tuberculosis on the basis of a diathesis, but the tuberculous lesion itself, involving as it does the prolonged absorption of partially split proteins from the necrotic foci.

All inflammatory exudations, serous fluids, diarrhœa, skin eruptions, etc., are Nature's ways of getting rid from the body of what is poisonous or undesirable in the system; so we have in succession imperfect nutrition, imperfect blood and protein formation, scrofulous or exudative diathesis, inflammatory reaction, extravasation of blood, dissolution, etc., as previously described (p. 123), and tubercle formation.

Protein sensitization is therefore a marked feature in the pretuberculous stage. This sensitization is not caused by the presence of tubercle bacillus, but most likely by the disturbance of nutrition and protein disintegration. Hence it is not the tubercle bacillus that causes scrofulous diathesis, but the diathesis or impoverished soil goes first and enables the acid-fast saprophytes to become pathogenic, or enables the tubercle bacilli that have entered from without to develop into tuberculosis. The most important thing is that all the catarrhal or exudative symptoms of early tuberculosis are due to bad feeding and bad nutrition or malnutrition. Therefore we can have symptoms of phthisis without tubercle bacillus, which we should call 'simple phthisis' and 'tuberculosis' when the bacilli are present. But the

symptoms are the same. They are physiological in the early stage, when Nature—a tremendous and tireless worker—tries to readjust and make good any loss or any deficiency, so that the system may continue to have such elements as fat, lecithin, cholesterol, etc., in normal quantities. When she fails through man continuing in his bad environment, the physiological symptoms which made for healing become pathological and make for disease. Such a rationale of tuberculosis seems to offer a better explanation of the phenomena of the disease, and is more in accordance with the findings of modern scientific thought than any theory put forward on the basis of bacteriology alone.

Heredity in Tuberculosis.

Closely associated with constitutional factors and diathesis is the question of the influence of heredity in tuberculosis. Does the environment make man or man make the environment? Does poverty cause disease or disease cause poverty? They are so related to each other that the cause is followed by the effect, and effect in turn becomes the cause. Some writers deny that heredity is a factor in tuberculosis, while others go to the other extreme, and give it an undue emphasis. Heredity is a bundle of environment, and environment today makes for heredity tomorrow. It is impossible to ignore the hereditary influence in the cause and cure of tuberculosis. There is a great mass of evidence to show that the children of tuberculous parents are more often tuberculous than those of normal persons. Physically inferior parents tend to pass on their defective constitution to their offspring. As Mellanby says, the malnourished as opposed to the starved maternal organism transmits undesirable weakness and tendencies to pathological change to its offspring. The countrywomen who are engaged in farm work and outdoor occupations and are well fed are most likely to produce vigorous and healthy children free from disease. But privation and hardship endured by the mother is bound to affect her child and make it a weakling. The horses introduced into the Shetland and Orkney Islands have degenerated in

size from scanty and inadequate food supply, and that size is inherited in their offspring. The Japanese boys and girls born in California and fed upon the products of its farms are larger at all ages than are the Japanese children born and bred in Japan, owing to the superiority of their food.[115]

But Nature has unlimited capacity to readjust herself to new conditions and rebuild the damaged body, provided there is sufficient vitality to work with. The measure of vitality is the measure of reaction to build anew. This is why heredity has two opposite effects. It can either perpetuate or accentuate disease, or make the offspring stronger in spite of bad heredity if there is sufficient vitality behind. This vitality is not altogether the result of good environment, though it is partly due to it. It has a deeper source than the physical environment—in the very personality and the inmost being of man.

Almost all workers are agreed that it is not infection that is inherited, but a constitutional weakness or a predisposition, which in some cases may be strong enough to run in families and cause tuberculosis in spite of good environment. Those who do believe in inheritance are divided into those who think heredity is an advantage and those who consider it as an adverse factor in tuberculosis. Pearson in this country and Pearl in America believe that heredity acts adversely in tuberculosis, while Drolet attempts to show that some degree of immunity can be inherited from the tuberculous parent. Pearson noted more deaths among patients of tuberculous parents, and Pearl,[116] from his statistical studies, concluded that persons suffering from clinical tuberculosis have a much greater amount of tuberculosis in their blood relations than have the non-tuberculous, and that in some degree, though not considerably, both the tuberculous and the cancerous are of weaker state constitutionally than those not having those diseases.[117] Variations in the natural immunity or resistance to tuberculosis may be partially determined by inheritance.

But heredity is not something fixed or unalterable, as eugenists affirm. The effects of bad heredity can be nullified

or neutralized by good environment in course of time, and *vice versa.* That even hereditary immunity against tuberculosis long enjoyed by the Jews can be influenced by environment is seen by the fact that the death-rate of the Jewish people in the lower east side, or Ghetto section, of New York City was the highest for that group in the city, whereas among those who removed to better tenements in the upper east side, or in the Bronx, with air and light in every room, the death-rate fell rapidly and markedly; and in the Brownsville section, where the Jews found individual homes and freedom from tenement dangers, the tuberculosis mortality in 1921 was 50 per cent. lower than on the east side, and as low as that of Framingham itself.[118] If slums, bad food, unwholesome physical and mental surroundings make for inefficiency, feeble-mindedness, etc., fresh air, improved home surroundings, good nourishing food, opportunities for recreation and exercise, and wholesome environment can profoundly change the effects of bad environment in the following if not in the same generation. In the light of most recent researches it has been shown that the interaction between body cells and germ cells can be very intimate and remarkable. Eugenists ignore that wise men can produce fools and fools can produce wise men, and that capitalists can produce labourers and labourers capitalists. A feeble-minded father like Micawber can produce a genius like Dickens. Each individual may have many inheritances good and bad which are beyond man's calculation or understanding. Environment in the long or short run can make for heredity, and environment and heredity are under the influence of personality. Human personality linked with the Divine power will be able to reverse the decision of the lower courts and turn the very weakness into strength.

The Decline of Tuberculosis.

The death-rate from tuberculosis has been steadily declining in the British Isles since 1851, and in other countries where economic and hygienic conditions have

shown a steady improvement. The decline began about thirty years before Koch's discovery of tubercle bacillus, and more than half a century before active steps were taken to prevent the disease. The rate of mortality was falling faster before the discovery of the bacillus than since, as Major Greenwood has observed.

The decline has been ascribed to many factors.

It cannot be said it is due to less infection. Bushnell[119] remarks that we have accomplished apparently nothing in stopping the dissemination of the tubercle bacillus. All attempts to destroy the bacilli by a frontal attack have proved unsuccessful. It is generally recognized that the universality of the disease throughout the civilized world makes it very difficult to prevent tubercle from developing in the human body.

It is not due to the pasteurization of milk, as there is as much decline of mortality among children in countries like Great Britain, where pasteurization is not carried out to any appreciable extent, as it is in countries like America, where it is more or less fully carried out. While the mortality among children under fifteen showed a decline from 136 to 33 per 100,000 in New York, it was reduced by 75 per cent. in England in children under four years of age, in spite of unemployment, poverty, slums, and overcrowding. Since (as already pointed out) no correlation has been found to exist between the incidence of tuberculosis among cows and the death-rate of children in an agricultural country like Sweden, the decline must have some other explanation.

Immunization.—The gradual reduction in the death-rate from tuberculosis is said to be due to the progressive immunization of the civilized population against the disease. If so, how is it that the poor, who are as equally tuberculized as the rich, show a much larger percentage of mortality than the well-to-do classes? And how is it that in such neighbouring countries as England and France there is such a difference in the tuberculosis mortality? In the years between 1911 and 1913 the death-rate in Paris was 394,

while in London it was 171 per 100,000; and for every 112 deaths in England from pulmonary tuberculosis France recorded 190 deaths. Also, why should there be a considerable variation between the death-rates in various cities of the same country? In America there is a difference between 176 in Los Angeles and 67 in Birmingham, Alabama; in Canada, 121 in Quebec and 44 in Saskatchewan; and even the coloured population in America shows a variation of 504 in Cincinnati and 112 per 100,000 in Atlanta.

Again, the Filipinos[120] as a whole are highly tuberculized, having been in contact with tuberculosis fully as long as most of the ancient stocks which make up the white population in the United States, and yet they show a high mortality rate—approximately two and a half times as much tuberculosis as the Americans. The Chinese have probably been in contact with the Filipinos for two thousand years and are highly tuberculized, and yet they suffer severely from tuberculosis. So that tuberculization cannot be the chief explanation of the decline of tuberculosis in civilized communities. The Filipinos live in poor hygienic conditions, overcrowding, and in ignorance of elementary sanitary principles. Sixty-four per cent. of their houses consist mainly of two rooms, and the poorer classes live in low, narrow buildings, where parents, brothers and sisters, sleep together with friends and visitors; hence their high mortality from tuberculosis. Evidently rural life, economic conditions, housing, environment, and other environmental factors exert a large influence upon the variation in tuberculosis mortality.

Isolation.—Epidemiologists like Sir John Robertson[121] have acknowledged that isolation in such diseases as scarlet fever, diphtheria, and enteric fever has not played an important part in the prevention of these diseases, and that in tuberculosis the isolation may take the form of placing the patient in good hygienic surroundings.

The best explanation for the decline of tuberculosis mortality seems to be: First, either from evolutionary changes in the character of tuberculosis, or from improvement in the living conditions of the people, the disease has

taken (as it has taken in diseases like smallpox, measles, enteric fever) a mild type, so that literally hundreds of cases have escaped detection, notification, and treatment. Secondly, the level of public health has been raised through more enlightened ideas of sanitation, fresh air, and personal hygiene, etc. And, most important of all, the decline should be attributed to the high level of resistance acquired from improvement in the social and economic well-being of the people. The more these beneficial agencies have been at work in a country, the greater has been the decline; and periods of economic and industrial prosperity have synchronized with periods of great decline. For instance, there was a huge drop in tuberculosis mortality three years after Peel's first reform of the Corn Laws, and another big drop in three years after further reform by the repeal of the Corn Laws, and so on, to which the reader's attention has already been called (Chapter VII.).

Drink versus Decline.—Alcoholism has exerted a sinister influence on the death-rate of many if not all diseased conditions. Abstinence from alcohol has helped to promote health, economic well-being, and the decline of tuberculosis, as seen especially in a country like America. The economic prosperity is brought about not only by increased wages, but also by the increased purchasing power through abstinence. Mr. Roger Babson, one of America's greatest economists, declares that the increased purchasing power of the American masses is largely due to prohibition, which has enabled them to spend the money they formerly threw away on drink in buying more food and clothes, houses, and motor-cars, thus increasing all legitimate industry.

Is it a mere coincidence that 'France' (according to the report presented by M. Marcel Labbe to the *Académie de Médecine* in May, 1926) 'is at the head of the alcoholic nations ruining her vigour and her health,' and at the same time has the highest general death-rate and highest mortality rate in tuberculosis; and that America, with her prohibition, should stand prominent among nations in reducing the tuberculosis mortality during the last few years? And

England comes between these two nations in the decline of the mortality rate and in her annual expenditure on alcohol, which came to £301,000,000 in 1926. While she spent £191,000,000 per annum on beer, she spent only £76,000,000 on milk (consuming 700 million gallons of milk as against 960 million gallons of beer), which brings the consumption of milk to less than one-third of a pint per head as against one pint per head in America. The consumption of milk plays a great part in the development of the physique of the race. The Medical Research Council in its preface to the Report on Diet for Boys says that an addition of one pint of milk a day would convert an annual average gain of 3·85 pounds per boy into one of 6·98 pounds, and an average annual increase of height from 1·84 inches to 2·63 inches. Unfortunately it is in districts (like Bermondsey, which in 1924-25 consumed 5,500,000 gallons of beer as against 1,210,000 gallons of milk) where much more milk is needed that the drink bill is usually the highest. If even a part of the £310,000,000 now spent on alcohol were diverted in buying more food, clothes, boots, and other comforts of life, how much more would the health, happiness, and prosperity of the masses be increased, resulting in a greater decline in the tuberculosis mortality.

Is the Decline in England Apparent or Real?—When we carefully look into the matter of the decline of the tuberculosis mortality in Great Britain, we find that it is not so great as it appears from the Registrar-General's reports.

(*a*) A great number of mild or very early cases are never recognized. The patient is ill for a few days, and some other name, such as influenza, or debility, or gastric indigestion, is given for his illness. He apparently recovers for the time being, and does not know the true nature of the condition he suffered from.

(*b*) If all the aged people who suffer from bronchitis were thoroughly examined, it would no doubt lead to an increase in the deaths registered as due to tuberculosis.

(*c*) A large number of deaths certified as bronchitis is primarily due to pneumonia, especially to broncho-pneumonia,

and to tuberculosis itself, as Drolet[122] states, and as the writer has already pointed out (p. 323). The number of deaths attributed to bronchitis in 1922 was 33,684, which is actually a little more than the number of deaths due to phthisis (33,505). In 1920 America, with more than twice the population of Great Britain, reported 11,609 deaths from acute and chronic bronchitis, which is 13 per 100,000, as against the English rate of 89 per 100,000. Drolet concludes his statistical examination by saying that the figures of tuberculosis in England and Wales are an understatement of the full ravages caused by the disease.

(*d*) Dr. R. Rosenfeld[123] of Vienna (of the Health Organization of the League of Nations) is of opinion that the establishment of State insurance systems has introduced a fallacy into statistics—at all events, in countries where notification of the cause of death is not confidential, as it is in Switzerland. He believes that out of consideration for the memory of the deceased, or of the susceptibilities of his family, or in order not to admit an error of diagnosis, the physician certifies the cause of death of an insured person as 'chronic bronchitis' instead of tuberculosis. Many practitioners, from motives of self-protection, are loath to notify until the disease can no longer be concealed from laymen, and even in cases of death from tuberculosis refrain from entering such as the cause of death when evasion is possible. This latter practice is probably a potent agent in the apparent fall of the death-rate in tuberculosis.

(*e*) Dr. Camac Wilkinson[124] suggests that the recent decline in the death-rate from tuberculosis was partly due to the loss of 700,000 men in the prime of life during the war, and had they not been killed, probably at least 10 per cent. would have died of tuberculosis. Even if we put it at 2 per cent., the tuberculosis mortality would be increased by 14,000 deaths.

(*f*) In the Framingham investigation of tuberculosis[125] the conclusion was drawn that the number of active cases of pulmonary tuberculosis might safely be estimated to be nine or ten times the number of deaths reported annually as due

to tuberculosis, and that actual deaths from tuberculosis might be estimated to be 22 per cent. more than the reported deaths from the disease. If so, we shall have to add more then 8,000 deaths as due to tuberculosis in England and Wales. Anyhow, we can safely draw the conclusion that the reported number of deaths is below the actual number, which probably is between 45,000 and 50,000 a year.

Besides, that the actual decline is not so great in tuberculosis when compared with the decline of some epidemic diseases is shown by the following figures:

AVERAGE ANNUAL DEATH-RATE TO EVERY MILLION PERSONS LIVING IN FIVE-YEAR PERIODS, 1901-1925.

	1901-1905.	1906-1910.	1911-1915.	1916-1920.	1921-1925.
Scarlet fever ...	126	86	61	32	29
Whooping-cough ...	301	253	209	156	131
Enteric fever ...	113	69	46	23	12
Phthisis	1,218	1,106	1,047	1,107	856

Tuberculosis still remains as the principal cause of death in Great Britain except cancer, whereas it stands fifth in the list of causes of death in America and sixth in Australia. Sixty per cent. of those who have died of tuberculosis were between fifteen and forty-four years of age — the most valuable and productive period of human life. Dr. Baskett observes that from 1842 to 1895 lives were saved at the average of over 40 per million living per year; from 1896 to 1908 there was less than no saving; from 1896 to 1923 the saving was only 17 per million living. As Dr. Harmer says, the rate of decline began to slacken soon after Koch discovered the tubercle bacillus. Had the disease maintained the same rate of decline after 1895 as before that date, it should have been practically extinct by this time (see illustration). But it still flourishes in spite of the unfounded optimism in those who compile and study statistics. There has not been any appreciable decline in the prevalence and mortality of tuberculosis during the last

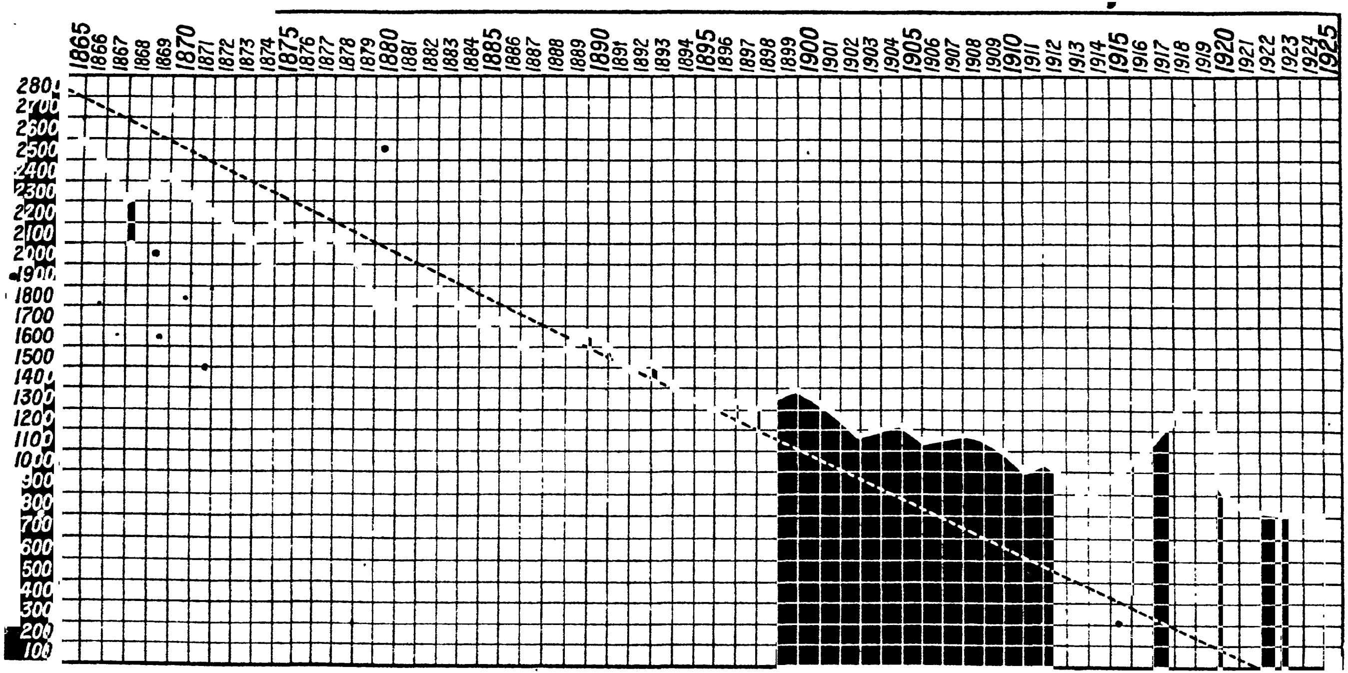


FIG. J.—DIAGRAM ILLUSTRATING THE MORTALITY OF PULMONARY TUBERCULOSIS IN ENGLAND AND WALES SINCE 1865.

Had the disease maintained the same rate of decline after 1895 as before that date, it should have been practically extinct by this time, as shown by the dotted line.

few years. The standardized death-rate for pulmonary disease was 843 per million in 1920 and 801 in 1924. But the statistics for the five years are not satisfactory, and it is suggested in Sir George Newman's report for 1924 that the conditions associated with lack of employment supply the probable explanation.[126]

Dr. John Guy,[127] Tuberculosis Officer, Edinburgh, who has noticed that the death-rate for pulmonary tuberculosis has remained practically stationary during the last few years, attributes this check to the decline to the prevailing unsatisfactory state of industry. It is true, as we have so often emphasized in these pages, that bad economic conditions existing in Great Britain from trade depression, unemployment, etc., have affected the purchasing power of the wage-earning classes, and lowered their resistance to tuberculosis. The revival of industry and a return to more prosperous trade conditions will no doubt help to bring about a better state of nutrition and health, and a fall in the death-rate from tuberculosis.

Prophylactic Immunization.

Since the searching investigation of Behring with bovo-vaccine, and Koch with tauramun more than twenty years ago, many attempts have been made to produce a protective inoculation against tuberculosis. But so far immunity has not followed the inoculation of animals. Tulloch and his co-workers, and many others, have failed to produce any lasting immunity either by inoculation of dead or living tubercle bacilli. Clive Riviere[128] has advocated the administration of small doses of raw tuberculous milk as the best means of immunizing children, but Sir Henry Gauvain considers it 'as a dangerous, filthy, and unnecessary doctrine.' Now a world-wide interest has been roused by Professor Calmette's prophylactio vaccine of newly-born infants against tuberculosis. His treatment consists in giving by mouth three doses, each of 10 milligrammes, of a non-virulent strain of tubercle bacilli to infants during their first ten days of life. He claims that this mild infection

confers upon the infants a sufficient power of resistance to protect against later infections. A considerable number of infants have now been treated by this means, and great hopes are entertained that Professor Calmette's system of vaccination will afford a certain measure of immunity to animals and human beings, and thus contribute a real solution to the tuberculosis problem. But after examining the results of vaccination, M. Moine[129] the statistician, concludes that during the first two years of life, out of 882 vaccinated infants 7 died of tuberculosis, which is 0·8 per cent., or 8 per 1,000. Another statistician, Dr. Y. Biraud, reports that out of 1,537 infants which were vaccinated, there was a mortality of 1·84 per cent., or 18·4 per 1,000, in the first year of life; whereas in Denmark the total death-rate for town and country from tuberculosis among infants under the age of one year was only 1·15 per 1,000. So that evidently the tuberculosis mortality among the non-vaccinated infants in Denmark is smaller than that of the vaccinated infants in France. The death-rate in France during the first year of life brought up in a tuberculous environment is assessed as 25 per cent. This high mortality, as well as the high general death-rate (as already pointed out), is no doubt due to bad economic and hygienic conditions prevailing in that country. Therefore the French mortality estimates—vaccinated or unvaccinated—should not be taken as applicable to other countries. As Mellanby observes, dietetic defects in pregnant and nursing women are responsible for some, and possibly much, of the illness and mortality of young infants. One remedy for infant mortality lies in maternal feeding. If Denmark is better off than France and the United States is better off than Denmark in the death-rate of tuberculous infants, it is because better nutritional and hygienic conditions prevail in those countries—probably more so in the United States than in Denmark.

Besides the failure of tubercle bacilli to produce an active immunization, the inoculation of attenuated living bacilli is fraught with danger, as they are likely to become converted

in warm-blooded subjects into pathogenic forms, as shown by Kolle, Schlossberger, Kaufmann, Schroder, and others. It has also been found that encephalitis can be caused by vaccination, either as a direct effect or as a sequel to the lowering of the general resistance of the body. Therefore there are serious objections to the inoculation of live vaccine of attenuated tubercle bacilli, as advocated by Calmette.

That nutrition, not infection, is the cause, the cure and prevention of tuberculosis is written large in the social history of every civilized country. It should be recorded here that not one single death from tuberculosis has taken place among children of tuberculous mothers who were treated in our sanatorium during the first four or five months of their pregnancy. Wholesome environment, good nutrition, and robust health of the expectant and nursing mothers is the only sure way of conferring immunity to their children.

Tuberculosis and Cancer.—For some time past it has been surmised that there is a relation between tuberculosis and cancer (p. 351). Recently Dr. T. Cherry,[130] after making a searching investigation of the mortality records in England and Wales during the past half-century, has come to the conclusion that since 1851 the two diseases have regularly caused 20 per cent. of all deaths after the age of twenty-five; that the reduction in the deaths from phthisis in early adult life is exactly balanced by the increase in the deaths from cancer after the age of fifty-five; and that the increase of cancer is due to the decrease of phthisis. To decide whether this correlation is real or apparent it is necessary that further investigation be made, not only into the statistical records of the people when they have died of these diseases, but into their social habits and environment when theywere living.

Remedial and Preventive Measures.

We can only consider this subject here very briefly. If tuberculosis still claims many thousands of victims every year in Great Britain, the question arises whether we are proceeding on the right lines to attack the problem. In most of the measures directed against tuberculosis the chief

FIG. K.—CHILDREN OF TUBERCULOUS MOTHERS WHO WERE TREATED AT MENDIP HILLS SANATORIUM.

Both mothers and children are doing well.

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mistake seems to be that sufficient attention is not given to the preventive aspect of the disease. The medical men are chiefly engaged in trying to find a specific cure for the disease, in spite of the repeated failures and disappointments. The Ministry of Health is largely concerned with the National Health Insurance, which deals with disease, disability, and pensions. The political parties are loath to take up the question of national health and efficiency, as it has no value as an election cry nor can bring any votes. The various municipalities, philanthropists, etc., have taken up schemes of treatment of tuberculosis rather than its prevention. The nation as a whole has allowed the vitality of the people to be lowered from physical ailments and defects brought on by malnutrition and wrong habits of living, and when tuberculosis has become a national menace and danger, it wakes up and spends millions in building sanatoria, and in making provision for after-care, colonies, settlements, etc., which is like shutting the stable door when it is too late.

Tuberculosis is both curable in the very early stages and preventable altogether if the fundamental causes are removed. A well-fed, well-housed, and well-educated people in matters of fresh-air life and personal hygiene will, in a few years, reduce the tuberculosis mortality to a minimum consistent with the economic situation. But as long as there are slums, overcrowding, unemployment, low wages, poverty, destitution, grinding toil, and intemperance, the nation will be riddled with tuberculosis, and all its efforts to cure the disease will be like attempting to bale out the water from a leaky ship. As fast as it is pumped out does the ship become filled again with water. We let the children drift into a state of malnutrition, debility, and disease, and then put into operation a whole scheme of surgical, medical, dental, and nursing services which palliate, but do not touch, the cause of the disease. It has been shown that the seeds of tuberculosis are sown in childhood, and that ill-health of children, adenoids, enlarged glands, decayed teeth, rickets, etc., are due to want of fresh air and nourishing food, so that adequate nutrition and housing of needy children and

mothers will do away with the necessity for various clinics and a host of palliative measures.

The burden of this volume is to emphasize two root principles of treatment and prevention of tuberculosis: (*a*) On the part of medical men to diagnose and treat early cases; (*b*) on the part of the nation to institute measures to improve the social and economic condition of the people.

(*a*) The diagnosis and treatment in the stage of early or suspected tuberculosis will result not only in saving nearly 80 per cent. of lives, so that they may return to their old occupation with the least possible delay and the highest capacity for work, but also in saving much misery and mental suffering and financial loss to the relatives and friends. It will also do away with much of after-care treatment, provision of workshops, colonies, etc., which entail a loss of many millions to the nation.

Unfortunately the anti-tuberculosis propaganda in this country has created a fear of infection among relatives and the employers of the patients, who are themselves afraid of exposure and of being branded as consumptives. By our system of notification we are unwittingly encouraging concealment of the disease and preventing those who are prepared to undergo early treatment but for the stigma attached to the disease. The result is that not more than 25 per cent. of early cases are treated in various sanatoria, and the rest are so advanced that any concealment of the disease is impossible. And the number of notifications is far below the actual number of cases suffering from tuberculosis. If, according to the Framingham investigation, the number of actual cases may be safely estimated as nine or ten times the number of deaths reported annually as due to tuberculosis, then the notification in England and Wales should disclose nearly 400,000 cases of tuberculosis every year, whereas in 1924 and 1925 there were only between 76,000 and 77,000 notifications of both pulmonary and non-pulmonary disease, and in 1924, 8,434 cases became known to the Medical Officers of Health, not from formal notification, but from death

returns, etc. As long as notification and propaganda work entail social stigmata, loss of employment, suffering and distress to tuberculous patients and their relatives, there can be no hope of getting a large percentage of early cases for treatment.

Sanatorium Patients, After-Care Colonies, etc.—The difficulties of sanatorium patients begin when they leave the institution. If ex-patients are to continue to keep well they require two things—good housing and suitable employment. There are serious difficulties in fitting a tuberculous person back into gaining a livelihood. One must remember that nearly half the consumptive people may be classed as permanently disabled, and the other half have only a limited capacity for work; and as they want rest and freedom from undue worry or exposure they are economically less productive and useful to their employers, and less reliable to be trusted with any permanent work. Above all, the fear of infection hangs over their heads and is a distinct obstacle to their employment.

Most of the training colonies have not so far proved to be a success. Permanent colonies or village settlements like Papworth (near Cambridge), where ex-patients obtain remunerative occupations and live with their families under best hygienic conditions, involve a large capital to begin with and heavy subsidies for maintenance. Besides, there is no guarantee that success similar to that of Papworth would be obtained in such settlements. The Public Health Committee of the London County Council in their report this year state 'that such enterprises as that of Papworth, while extremely interesting and valuable, cannot offer a solution of the problem of providing suitable employment or occupation for urban tuberculous persons after discharge from sanatoria.'

If the colony is established in connection with a sanatorium, it will serve a useful purpose in giving an extension of treatment to patients who will at the same time be under medical supervision. The home treatment of tuberculous persons is both economical and effective, provided that home and financial conditions are satisfactory. The Home Hospital

experiment in New York, where tuberculosis is treated as a family problem, has achieved better results than those of other sanatoria in America. While the National Tuberculosis Association records 39 per cent. as able to work and 13 per cent. not able to work, the Home Hospital gives 59·9 per cent. as able to work and 12·8 per cent. not able to work.[131]

(*b*) Tuberculosis touches the social life of the people at many points, and is complicated with larger national, political, municipal, and economic issues. As one surveys London and crowded towns and chief centres of population one sees that a vast number of people are miserably poor, deprived of a fair chance to live full and contented lives, their children badly nourished and ill-trained, their houses pitifully cramped and squalid, and their outlook hopeless of improvement.

Tuberculosis to a large extent is a poor man's disease, and any social and economic betterment in the way of adequate wages and good housing would mean improved nutrition and health and well-being. Adequate nutrition plays a greater part in warding off tuberculosis than any other single factor. The amount of tuberculosis is in direct proportion to the income of the workers. In countries like America and Australia, where wages are highest, the incidence of tuberculosis is lowest; whereas unemployment and low wages, by lowering nutrition and vitality, increase the incidence and mortality of tuberculosis. Employment and wages in their turn depend upon the trade and industrial conditions. The State, therefore, should make it one of its aims to remove obstacles and encourage facilities for the revival of trade and industry.

If men and women are half-starved and badly housed they cannot do efficient work. It is to the interest of the State to see that its workers are properly fed and housed and the standard of their living conditions raised, as this means not only better nutrition and health, but more efficient and increased output of work, which would save many millions of pounds now spent on account of disability and disease.

Poverty leaves an indelible mark on the physique and morale of the children, in whom the joy of life is crushed, and

a healthy development of the body and mind is arrested. To take hold of them in their infancy, before they are overwhelmed with illness and disease, and to see to their health and nutrition, as well as those of expectant and nursing mothers, constitutes one of the most important means of attacking tuberculosis at its very root. The Grancher system, which was established in France in 1903, is doing good work in that country, and a modification of Grancher's method has been carried on by the Borough of Hastings Tuberculosis Care Committee during the past eight years. But its one great drawback is that it deprives the little ones of their mothers' love and care, and the tender solicitude which they so much need in the formative years of their lives, and hence it may not be widely adopted in England.

To be concerned about infection before attending to the health and nutrition of the people is to put the cart before the horse. Infection rears its head only when health is impaired by poor nutrition and bad environment. Attention should therefore be given to promote public health on the part of the State and personal hygiene on the part of the individual. Just as the internal organs of the body work together for the common good, and also work individually to elaborate their own secretions, so both collectivism and individualism should operate together in a nation. Public health measures should include: Opportunities for the people to enjoy the fresh-air life; provision of public parks, playing-fields, etc., of pure water and milk, open-air schools; measures to keep down unemployment; increased earning power of the masses, abolition of slums, building of sanitary houses, cheapening of food and of its distribution, greater production of essential foods which are too dear for the people, and rendering available those natural foods which have been too much refined, etc.

The present taxation methods impose a real burden on a great mass of the people and tend to increase poverty. Dr. Baskett and the writer have shown that a higher taxation means a greater increase of tuberculosis, while a rise in real wages means decline of the disease. The State has two

alternatives to choose from: To ensure a living wage for the workers so that they may look after and provide for their families and children, or allow wages to remain low and unemployment to continue, and then feed the children and mothers of the poor and put into operation various clinics and doles, and thereby increase the rates and taxes—which is simply robbing Peter to pay Paul. It would be more economical to keep people healthy than to spend millions in curing them after they have lost their health. The physicians, who are hitherto trained to treat the sick, must learn to treat the so-called well, as they do in some Oriental countries. According to the Registrar-General, the total annual direct cost of tuberculosis to the community in England and Wales is no less than £14,250,000, and the cost of sickness and disability disablement no less than £150,000,000 a year.[132]

Lastly, tuberculosis opens still wider issues, such as the enforcement of economy (national and municipal), retrenchment, peace, and reduction of taxation—all of which, by contributing to the well-being and happiness of the people, help to reduce the incidence and mortality of tuberculosis. It requires an enlightened social conscience and a moral fervour to rouse the apathy of the governing and middle classes to realize the great economic importance of health, and to appreciate Emerson's dictum, 'the first wealth is health,' so that they may bring pressure upon the political parties to institute reforms and measures necessary for the promotion of the general welfare of the community and the prevention of disease, including tuberculosis.

5. Some Observations on Tuberculosis in India.

'There is nothing in which men approach so near the gods as when they try to give health to other men.'—Cicero.

We pluck the world and make of it
  A something new from hour to hour;
We reconstruct the Infinite
  Each moment with our striving power.
Chattopadhyaya.

In this short review of tuberculosis we can only briefly consider the vast problems that confront the many millions of the Indian people. Tuberculosis is not a new disease in that country. Long before the Buddhist era (500 B.C.) the Indian physicians, Charaka and Susruta, left in their writings a full description of consumption, its causes, symptoms, and treatment. So the disease must have been in existence through the lapse of many centuries, disappearing or displaying itself from time to time according to the various phases of social and economic conditions through which the people were passing, but always entrenching itself in some parts of the country, especially in crowded cities and towns. During the last few decades the impact of the West with the East, and all the changes and social and economic upheavals which such an impact has brought, has given a new life to tuberculosis. In the last forty years it has been gradually increasing in all the principal cities and manufacturing and industrial centres, among all classes and races, from the humbler ranks of coolies, mill-hands, and servants, to the educated and well-to-do communities. Today tuberculosis has become one of the most serious and urgent problems which require the earnest attention of both the State and the people of India.

The Present Situation.—While the disease has been steadily declining in Europe, the United States, and Australia, it is spreading in India far and wide, and extending from towns to the surrounding villages and rural areas where the people return home to die after contracting the disease in the crowded and industrial cities. The middle classes,

especially the junior clerks with small and fixed incomes, college students burdened with the strain of long hours and a heavy curriculum, and child-mothers badly nourished and with poor stamina, have suffered most from the ravages of the disease. It is the most important tropical disease at present—far more important than leprosy—and undoubtedly the most fatal in the larger towns and cities of India. One death in every ten of the total mortality is caused by tuberculosis, and in some Indian cities, out of three deaths recorded among adults, one is due to tuberculosis. It takes a heavy toll among men and women in their very flower of manhood and womanhood. About 60 per cent. of cases occur between fifteen and thirty years of age. The death-rate is appalling among younger females in the city of Calcutta, where the tuberculosis mortality at the child-bearing age is six times as much as that of males, owing partly to the badly-lighted and ill-ventilated conditions of the Zenanas. The Mohammedan women suffer more than Hindu women because of the stricter purdah system prevailing among them. It is truly sad (only those who have witnessed can realize the poignancy) that as buds wither before they open to the light of day, so many promising young girls fade away at the touch of tuberculosis when the wifehood or motherhood is pressed close upon their undeveloped bodies.

The Extent of Tuberculosis in India.—It is unfortunate that we have no reliable statistics as to the extent of mortality from tuberculosis for the whole of India. The registration of births and deaths in municipal areas, except in such towns as Calcutta and Bombay, is very defective and misleading. The registration of deaths in the villages, where nine-tenths of the population live and die, is in the hands of illiterate watchmen, and is far from accurate. Thousands of cases of tuberculosis are either missed altogether or mistaken for such diseases as malaria, enteric, or other continuous fevers, bronchitis, broncho-pneumonia, etc. While in some places many cases of deaths from tuberculosis are certified under 'respiratory diseases,'

'fevers,' 'other than phthisis,' 'pyrexia of unknown origin,' 'other fevers than smallpox,' in others wholesale omissions had been discovered in the death returns. For instance, while the mortality due to respiratory diseases reported at the Keranigani thana from 1911-12 was 60, a special staff enquiry made it out to be 910. A house-to-house enquiry revealed that in Dinajpur in 1912 35·5 per cent., in the Faridpur district 29·13 per cent. of deaths were found to be unrecorded; and Dr. Brahmachari,[133] who was Health Officer of Cossipur-Chitpur district, put the omission as high as 66·2 to 78 per cent. in the police registration of deaths.

(*a*) If we apply to India the result of the Framingham investigations, which found that 2 per cent. (1 per cent. active and 1 per cent. arrested cases) of the population were suffering from tuberculosis in a recognizable form, then we have to record that 6,000,000 (the population of India is 319,000,000) of persons are suffering from tuberculosis, of whom 3,000,000 are in an active stage. From our own experience we have seen that the disease has proved fatal in 75 per cent. of active cases, which means that there is an annual mortality of more than 2,000,000 from tuberculosis.

(*b*) In 1922 the Sanitary Commissioner of Bengal reported that in Bengal Presidency (which contains a population of 46,000,000), 100,000 persons die from tuberculosis. If this rate is applied for the whole of India, we get an estimated tuberculosis mortality of 700,000.

(*c*) We think the truth probably lies between these two figures, *a* and *b*. In 1913 we calculated from data then available that the annual death-rate from tuberculosis could not be less than 900,000 to 1,000,000. This figure is remarkably verified by the study of the annual report of the Public Health Commissioner, 1921, which records 6,000,000 deaths (to be more accurate, 6,036,931) in British India among a population of 247,000,000. The Census Report of 1921 drew attention to the fact that about 30 per cent. of deaths in India are unrecorded, which means that the reported 6,000,000 should be increased by another 2,000,000 deaths. And if we add another 2,000,000 deaths from the

Indian States (which is calculated from the death-rate in British India, which is 25·5 per 1,000) among a population of 72,000,000, we get a grand total of 10,000,000 deaths for the whole of India. Now the death-rate of tuberculosis has been estimated as 1 in 11 by Dr. Chandra Seker of Madras, as 1 in 7 or 8 by Dr. Lankester, and by Dr. Bentley and ourself as 1 in 10, which gives an annual mortality of 1,000,000 from tuberculosis.

Causative Factors.

To survey the many causes that underlie the prevalence of tuberculosis in India, and to unravel and assess their relative value, requires a breadth of vision, a sympathetic insight, and a knowledge of the living conditions and the psychology of the Indian races. As long as the Indians lived the simple, primitive life in the open air, tilling the earth, eating the natural food, communing with Nature, and pursuing their daily avocations in a leisurely way, they were free from tuberculosis. But the contact with Western civilization brought such profound changes in their social, economic, and industrial life, and in their every-day habits of living, that in the course of time they opened the door to tuberculosis.

Overcrowding and Insanitary Conditions.—The first group of causes that calls our attention is overcrowding, housing, unhygienic and insanitary conditions. Overcrowding is extremely bad in India, especially in many of the older cities, where thousands of houses are packed close together and built with no provision for light or ventilation. Cities like Delhi, Lucknow, etc., are full of slums, blind alleys, and narrow passages, where the sun never shines and fresh air never penetrates, and which easily outrival any of the slums we have seen in London. The Census of 1911 showed that nearly 80 per cent. in Bombay live in one-room tenements. The growth of the Indian population, the congestion of cities, and the reduction in the living accommodation, have accentuated this crowded and insanitary condition. So dense is the population, that in certain parts of Lahore

465 persons are crowded in an acre, in Cawnpore 563, in Bombay 638,[134] whilst in the worst parts of a city like Leeds it is only 104, and in Birmingham 101. The density of the population is in direct proportion to the incidence of tuberculosis. For instance, in Bombay,[135] among those living in one room, the incidence of tuberculosis was 66·13 per cent.; among those living in two rooms, 24·1 per cent.; among those living in three rooms, 10·5 per cent.

The sanitary standard as regards conservancy, drainage, disposal of sewage, clean water supply, and good housing is very low in many parts of India. The housing condition of even well-to-do classes in respect of hygiene, ventilation, etc., falls short of modern artisan dwellings in England.

Economic and Industrial Conditions.—The majority of the Indian people pursue agriculture and live in villages. Each village was once a self-contained unit, supplying its own needs by its own handicrafts, which found employment for everyone in the village. But the invasion of foreign manufacture and the competition of machine-made goods have disorganized and ruined India's industries, so that the artisan class—the hand-spinner and the hand-loom weaver—had to abandon their traditional occupations and take either to agriculture or go into factories in the cities, which brought overcrowding of towns and manufacturing centres, scarcity of houses, slum tenements, dearer rents, increase in the prices of food, and all the evils of modern civilization. This is seen in industrial cities like Delhi, Bombay, and Calcutta, which, with their cotton mills and jute factories, etc., record a high incidence of mortality from tuberculosis.

Low wages and poverty are more intimately associated with tuberculosis in India than any other single social or economic cause. Poverty is a terrible curse in India, where many millions live on one meal a day and are chronically underfed and half starved. There are fifty millions of labourers, many of whom live at the very margin of subsistence. The middle classes have also suffered, and, owing to their early marriage, large families, small incomes, and chronic debt, and having to maintain a certain position, they

are unable to spend much on nourishing food, and are in a state of constant want and ill-health.

To take only two items of the daily meal: The common diet of many of the poor, which consists of polished rice, dal, vegetables, and condiments, has a parallel in the diet of the English poor—white bread, margarine, and tea—and both are deficient in nutritive quality and unable to maintain sound health. Rice, which is the staple diet of India's many millions, is an incomplete food, and is poor in protein, mineral elements, fat, and vitamins; and various milling and refining processes have still more deprived the grain of its proteins, mineral and vital elements, and those who solely subsist on it have the worst physique and the lowest resisting power in India.

There is a great shortage of milk in India. In former times, when grazing lands were free and almost every householder kept a cow, the health of the people did not suffer, as they had sufficient nutrition to draw from the milk and milk products, unpolished rice, and vegetables. But now pure milk and ghee (clarified butter) are almost unobtainable by the poor and the middle classes in sufficient quantity to maintain their nutrition. The great importance of milk and its products in the dietary of the people can be realized when it is seen that it is the only source of animal protein (the other source being eggs, which are not eaten by many millions) available for Indians who are vegetarians. In the wealthy city of Calcutta the daily supply of milk is reckoned as 3,000 maunds,[136] which works out at a little more than 3½ ounces a day per head of the population. In many other less-favoured cities even this may not be procured. The poor and the middle classes cannot afford to buy milk at the prevailing price of 2½ seers for a rupee (4d. a pint). If this price is dear in England, it is much more so in poor India.

The children have suffered mostly from want of milk in their daily dietary, which is so necessary for their growth and development. This dearth or dearness of milk is responsible for the decline of health and progressive deterioration of Indian boys and girls, many of whom go

without it every day. The report of the Calcutta University Student Welfare Committee states that Bengali boys begin to degenerate from the age of sixteen, getting deaf and weak-eyed. The *Indian Medical Gazette* rightly calls attention to the fact that an enormous number of students in schools and colleges suffer from diseased tonsils, adenoids, enlarged glands, catarrh of the ear, nose, and throat, deformed chests, and poor bodily development—all due, as we have seen in the case of English children, to inadequate food and malnutrition, which develops into tuberculosis in the years of adolescence.

The production of food has not increased with the growth of the population, which partly accounts for the scarcity or dearness of the necessaries of life. The country is flooded with tinned milk and butter and other tinned articles of diet, which are mostly vitaminless foods, the consumption of which still more lowers the nation's vitality. This faulty food and poor nutrition is the fundamental cause of tuberculosis, and, in fact, of the majority of ailments in India. The margin of the staying power of the people is so small that they succumb literally in thousands to any epidemic disease that may prevail at the time.

So far overcrowding, insanitation, and faulty nutrition are causative factors of tuberculosis, common both to England and India; only they are far worse in India than in the West. There are also other factors which require consideration.

The **Purdah System** is an important predisposing cause of tuberculosis. To ensure privacy and seclusion, the women's apartments are situated in the inner part of the house, which is often sunless, ill-ventilated, and insanitary. Hence the disease is much more common among women than men. Dr. E. Muir[137] says that the death-rate of females between the ages of fifteen and twenty was 7·2, and between twenty and thirty 7·1 per 1,000, as compared with 1·2 and 1·8 respectively in males of the same ages; and if this average is kept up in passing between the ages of fifteen and thirty, one out of every ten women dies of this

terrible plague in Calcutta. The more strictly the purdah is observed the greater the mortality, as among the Mahommedan women; and the less it is enforced the less the mortality, as among the Burmese women.

Child Marriage is a cruel system, and undermines the strength and vitality of the child-mother, who brings into the world children more weakly and immature than herself, and so degeneration of the race goes on from generation to generation, and tuberculosis spreads. In Bombay, in 1921, out of 1,000 girls, 548 were married between ten and fifteen. This early marriage, with frequent pregnancies and periods of lactation, so debilitates the mother's constitution that there is a terrible toll of stillbirths and infant mortality in India. In Bengal Presidency alone, which is as large as Great Britain and Ireland, there were 64,000 stillbirths in 1924, and probably this is an under-estimation. At this rate there would be nearly a quarter of a million stillbirths in the whole of India. Child marriage is the principal cause of the heavy mortality among infants, which in Bombay, in 1921, rose to 666 per 1,000, and in 1925 was 400 per 1,000, as compared with 70 per 1,000 births in England and Wales in 1926, 98 in France, and 101 in Germany. It is reckoned that 5,000 children die every day, or 2,000,000 children die annually within the first year.

Among other social evils that favour tuberculosis must be mentioned the dirty habit of indiscriminate spitting, which spreads infection where the soil is favourable; the joint family system, which accentuates the evils of overcrowding and insanitation; the caste system and intermarriage within the caste.

Heat and dust are two great enemies of India favouring the course of tuberculosis. Diseases like malaria, continuous fevers of unknown origin, so weaken the body as to fan the flame of the disease. Syphilis and intemperance are becoming formidable evils, and when accompanied with tuberculosis make many a case hopeless.

To explain such a deplorable state of things the following facts may be summed up: There is no country in the world

where poverty and destitution is so appalling as in India, where millions of people are in chronic want, where protein intake is so small and the diet so poor. There is no country where epidemics like cholera, plague, and influenza carry off so many thousands every year. There is no country where still-births are so common, infant mortality so high, and where the death-rate, as in some parts of Bengal and Punjab, actually exceeds the birth-rate. There is no country in the world where the average expectation of life is so short as in India. The average human life is lengthening in other countries. In England it has risen from 49 to 50 years, in America from 56 to 58 years,[138] and in New Zealand[139] they have all but attained for their people an average length of life of 65 years. Even in Japan,[140] an Oriental country, it is as high as 47, whereas in India it has gone down from 25 to 22·9, and now it is reckoned as 22 years.

All these are ominous and disturbing facts, which speak eloquently as to the true economic and health conditions of India. Why is this so? Why is tuberculosis so prevalent in India? Unless we closely enquire and dig deep below the surface of things we shall miss the real significance of what has made tuberculosis so widespread in India. Meredith, the novelist and poet, once said that "unseen things are more." He who is blind to the inner cause is ignorant of the real cause.

The Inner Causes.—The wide prevalence of tuberculosis cannot entirely be due to a greater contact of people and increased means of communication and greater travelling facilities brought about by railways at the present day, as Dr. Sprawson thinks. In the not distant days there was plenty of contact of the people in the many social and religious gatherings, fairs and festivals, visits to shrines and pilgrimages to distant lands, all of which have afforded Indians many opportunities to come together in social and religious intercourse; though perhaps not to such an extent as since railways have come into existence. Sweany[141] observes that the North American Indians, even after a thorough contact with the white race, did not develop

tuberculosis until they began to forsake their native customs and became subject to a change from the outdoor to indoor life with insufficient food.

The high tubercle incidence is not altogether due to the effects of heavy rainfall and humidity, as Dr. Lankester and Sir Leonard Rogers contend. The Himalayan Hill Stations have a high rainfall and great humidity, but the tubercle rate is only 3·6 per mille, whereas the central part of Madras Presidency has a comparatively low annual rainfall of 20 to 30 inches, and yet it has a high tubercle rate of 11·7 per mille.[142] High monsoon winds by lowering vitality may partly account for the high death-rate from tuberculosis; but if there is vitality behind, the presence or absence of winds will make no difference, as has already been noticed (pp. 132-133). It is not high winds, but the low vitality of the people that is the deeper cause of tuberculosis. Besides, the dry intense heat and hot winds and dust are far more conducive to the development of the disease than the humidity caused by the monsoon rains. In fact, a certain amount of moisture, besides allaying the irritating dust, helps to soothe the mucous membrane of the nose, throat, and the respiratory passages.

Again, many writers attribute the prevalence of tuberculosis in India to the 'virgin soil' presented by the Indians. But there has always been more or less tuberculosis in the country. The Indian physicians all down the many centuries have, in their writings and teachings, warned the public about the presence of the disease, and prescribed as part of the treatment, animal food, goat's flesh and milk, ghee, pepper, and garlic, etc. We have already called the reader's attention to the sanatorium at Minnesota, in which district there seems to be a larger proportion of uninfected, and presumably unprotected, adults than in the eastern districts of America; and should they get exposed to infection, as are the sons and daughters of Finnish farmers, employed at the Minnesota sanatorium, they would be in a similar position to the non-tuberculous people in Oriental countries, and would be likely to succumb in

large numbers to the disease, and yet there have only been ten cases of tuberculosis out of 1,000 employees at the sanatorium. It is not the 'virgin soil,' but a poor soil, in a soil made poor by a change in diet and nutrition, that we should look for the prevalence of the disease.

Once again, we cannot attribute the greater incidence in these days solely to the bad social habits and insanitary conditions. There have been for many decades, if not centuries, crowded cities and insanitation, famines and epidemics, malaria and cholera, child-marriage and purdah, caste and the joint family system, and yet tuberculosis had not become a menace as it is now. Something more is wanting to give a dynamic effect to the spread of tuberculosis. What is it? It is the lowered vitality of the people from low protein intake, and from an ill-balanced and deficient dietary extending for years, that is the prime cause of tuberculosis.

Physical.—True, the vitality has been lowered by bad social habits, economic evils, insanitation, malaria and other debilitating diseases, but the most important cause of the lowered vitality of the people is from chronic shortage of the necessaries of life, and underfeeding from refined, adulterated, tinned, and vitaminless foods which have increased the susceptibility to respiratory diseases and tuberculosis. It can be taken as an axiomatic truth that those nations (such as the pastoral tribes of Asia, Arabia, Northern Africa, Abyssinia, Mesopotamia, and the Balkan States, as well as the Sikhs, the Rajputs, and the Pathans in India) whose diet consists of a liberal allowance of animal protein, milk, butter, cheese and curds, wholemeal flour, and vegetables, possess a high degree of physical vigour, courage, and endurance, while those, such as the Indian races in Bengal and Madras, who live chiefly on polished rice, dal, and vegetables, exhibit the lowest physique and development. The newer knowledge of nutrition has revealed the fact that the physical efficiency and well-being of any race is largely a matter of the food they eat.

Psychological.—Side by side with the defective nutrition there is the disturbed mind, as seen in three ways:

(*a*) The Western civilization has brought an increase of population, congestion of cities and towns, dear rents and dear food, a keen struggle for existence, and mental stress and anxiety. The West is full of optimism, while the East is given to pessimism and fatalism: and the inherited fatalistic temperament of centuries cannot stand the onward march of Western civilization or the evils like tuberculosis which it brings in its train. It simply yields and succumbs instead of fighting or adapting itself to the new environment.

(*b*) The East pursued its daily avocations in a calm and leisurely way without haste or hurry. Any undue bustle and speeding-up of its daily activities comes like a shock to the even tenor of its spirit, owing to long heredity and low protein food. Its machine can only go at twenty miles an hour, but when it is rushed to sixty miles it simply fails, and after a while breaks down.

(*c*) In the strenuous life and restless activity imposed by the West, the East has lost much of its calm and peace of mind, and it has thus been deprived of one great source of power and strength that comes from living in an atmosphere of quiet contemplation and restfulness. These inner psychological and emotional disturbances to which the Oriental races are peculiarly susceptible should have a high place among the causative factors, as they not only intensify the effects of bad nutrition and derange metabolism, but they also kindle a fire which brings tuberculosis to life.

The Course and Characteristics of Tuberculosis.—Pulmonary tuberculosis is rather uncommon among Indian children, who are generally breast-fed. It is after the fifth or sixth year, when they cannot obtain sufficient milk or nourishing food, that their nutrition fails and they begin to decline. The earliest sign of disturbed nutrition is seen in the enlarged glands, which is really a sign of Nature's protective mechanism. This is why the majority of scrofulous cases with enlarged glands is not followed by tuberculosis in the adult period. Abdominal tuberculosis beginning in the

mesenteric glands is very common all over India in children and adults, and shows itself long before there is any manifestation in the lungs. Ileo-cæcal tuberculosis with tenderness in the right iliac fossa, as Sprawson[143] points out, is a common complication. This wide prevalence of gland tuberculosis is an indication of how very general faulty and poor nutrition is throughout India. The intestinal tuberculosis is not caused by bovine infection, as bovine tuberculosis practically does not exist in India. The common prevalence of intestinal tuberculosis lends colour to Calmette's theory that the infection enters the system primarily through the alimentary canal. But the writer's contention that enlarged glands are a sign of malnutrition rather than infection is supported by many clinical facts, and also by clinical experience from India. Cow's milk in India is poor enough in its quality, as the cows are badly fed and do not get green fodder a great part of the year; but when it is thoroughly boiled, and often more than once, it loses every vestige of vitamins and much of its nutritive quality. Here lies one of the chief causes of tuberculosis in childhood, and one of the chief wants in India—pure fresh milk from grass-fed cows.

As long as there is sufficient vitality, the tuberculous condition does not proceed further than enlarged glands; but, if nutrition continues to fail, and the resisting power breaks down, the next earliest sign is fever. Tuberculosis takes an acute and rapid course among the adults in India, and attacks many a young married woman after her first confinement. The fever shows itself in the form of pneumonia, or broncho-pneumonia, which ends fatally in a large majority of cases within six months to a year, and even less. Many a case diagnosed as pneumonia, remittent fever, or malaria, is really acute tuberculosis, or what is called galloping consumption. The fever at first is not accompanied by any physical signs, when the diagnosis may seem difficult or doubtful. But the golden rule followed by the Indian physicians should be kept in mind—that, if a fever continues for a month to forty days, it is caused by consumption.

Remedial Measures.

The problems presented by tuberculosis in India are more formidable and complex than they are in Europe or America. Any attempt to draw up a scheme of remedial measures to meet the needs of 319 millions of people, of many races, castes, and tongues, would be a gigantic task. Here we can only indicate some of the main principles to guide us in the treatment and prevention of the disease. The trend of the argument pursued in these pages will prepare the reader to approach the question of any curative measures from the social, economic, hygienic, and nutrition point of view. Tuberculosis is not a local but a constitutional disease, taking many years to develop in the body, and therefore we cannot place any reliance upon remedies such as tonics, drugs, injections, etc., to produce a fresh current of new blood in the system. But a well-balanced diet and adequate nutrition can renew life's vitality and recuperative powers of the consumptive, as witnessed in hundreds of instances in sanatorium patients. The tuberculin treatment has been recklessly used in India, both by general practitioners and unqualified men. Whether because of a poor soil or the sensitive constitution of the Indians, its administration has caused the disease in so many cases to flare up and end fatally, that a word of caution is necessary against its use. It is not by trying to destroy infection, but by helping to build up man's vital powers, that we can hope to lay a sure and certain foundation in the eradication of tuberculosis in the near future.

Social Reforms.—In the first place, social reforms are urgently needed to raise the standard of health and efficiency of the people. The salvation of India depends upon Indians themselves, who should give a helping hand in breaking down those age-long customs that have kept India backward among the nations of the world: Such social customs as purdah (purdah has been abolished in Turkey and among Mohammedans in Russia), child marriage, and careless spitting can be combated more effectively by an enlightened conscience and public opinion, and the moral and spiritual

impulses of the people, than by legislative or any other measures. Other social questions, such as food reform, temperance reform, housing reform, education reform, such as reducing the number of school hours and the heavy curriculum of boys and girls, reform in raising the age of consent and the marriage system, are beyond our scope for discussion here, although they are all very necessary in raising India's efficiency, and should form a part of the programme of the general improvement of the people.

Sanitary Measures, etc.—Municipalities, City Corporations, Boards of Health have a great work to do in:

1. Giving attention to village sanitation, hygiène, the clearing of jungle, the provision of a pure water supply, the organization of conservancy.

2. Replanning of old cities, opening up congested areas, providing open-air spaces, parks, and public gardens, some of which may be reserved for the use of purdah women.

3. Open-air schools with playing-grounds for children, teaching of hygiene in schools.

4. Controlling the building of new houses and seeing that they have a free access of fresh air and light in every part.

5. Distribution of the population to the suburbs by cheap train and tram service, inspection of water and milk supply, etc.

All these public health measures that aim at improving the general health and well-being of the people are efforts that are likely to reduce the incidence and mortality from tuberculosis.

Sanatorium Measures.—There are at present about seventeen or eighteen homes and sanatoria distributed all over India for the treatment of tuberculosis. A State-aided sanatorium is at Bhowali, accommodating seventy-five beds for the United Provinces. There is one at Almora, one at Dharampore in Simla Hills, supported by a society in Bombay and receiving aid from the Panjab Government and the Patiala Durbar; one or two at Punchgani; one at Karla, which is closed during five months in the year owing to heavy monsoon rains; one at Madanapalle, South India. The

Calcutta Medical Aid and Research Society has recently opened a sanatorium at Judabpore for Bengal. The writer has opened a home for early cases at Pallavaram, about twelve miles from Madras, and is also arranging for one near Bangalore. Besides these institutions, there are special wards opened in various hospitals in India for the admission of consumptive patients. It is reckoned that there are not altogether more than 500 beds in these institutions which are specially adapted for the open-air treatment of consumption, and of these only about 10 per cent. are available for the poor. Not only are these sporadic efforts inadequate to meet the needs of 319 millions, they do not touch even the fringe of the tuberculosis problem. To attack this protean disease successfully, a well-thought-out plan of campaign should be put into operation by the combined efforts of the Government and the municipality of every big town.

The Group System.—We have long advocated the following group scheme. Briefly speaking, every big city should have a combined system of a dispensary, a sanatorium a few miles from the city, a hill sanatorium, a marine sanatorium for children, and a garden colony. The dispensary would serve as an information bureau, a clearing house, and an out-patient department, from which suitable cases would be sent to the city sanatorium. Those patients who do not improve there, or require further treatment, would be sent to the hill sanatorium. The marine sanatorium is chiefly intended for the treatment of scrofulous or tuberculous children and of surgical tuberculosis. The garden colony would contain the sanatorium already spoken of, a hospital for advanced cases, and would serve the purpose among other things as an after-care institution for ex-patients who, if necessary, would be kept under further observation and be trained in some useful outdoor occupation, such as gardening, poultry-farming, weaving, etc. The colony or garden city would be laid out with spacious walks, wide avenues, sanitary cottages with large gardens for ex-patients and their families, and for those threatened with tuberculosis. It would also contain an open-air school for children, a dairy farm, a

lecture hall, places of worship, etc.—in fact, it would be a self-contained ideal village embracing many activities, partly self-supporting and partly helped by the Government and the municipality.

Economic Measures.—But though the social, sanitary, and sanatorium measures may help a great deal, they cannot solve the root problem of the prevention of tuberculosis. We shall still be baling out water from the leaky ship. The fundamental basis of health and well-being is nutrition. Proper feeding plays no small part in raising the recuperative powers of the individual and protecting him from disease and infection. If lowered nutrition is the chief cause of tuberculosis, improving the standard of nutrition will be the most important means of arresting and preventing the disease. Tuberculosis is ultimately an economic problem. Therefore the most urgent question one has to face is how to improve the economic condition of the people. With the low wages and high prices prevailing at the present day in India, one can see how it is beyond the resources of a large percentage of the people to obtain a well-balanced food to maintain health and efficiency. Lieut.-Colonel J. W. Cornwall,[144] who worked out the question of Indian diets necessary to maintain health and vigour, found that a reasonably good diet could not be purchased for much less than 12 annas for 3,000 calories, or about 23 rupees per month per head, and that though a man might provide himself with 3,000 calories for 6 annas, the food would be ill-balanced and in several respects a deficient diet. This means that a man, his wife, and two children must spend 69 rupees on food alone (two children count as one adult), without taking into account such expenses as rent, fuel, light, clothing, and other necessaries. On the other hand, Rev. G. M. Leith, investigating the conditions of the poor in Madras, on the same lines as Mr. Rowntree, of York, did in England, worked out that the bare minimum wage for a poor Indian is 3 annas per day, or 9 annas for a man and his wife and two children, or 17 rupees per month—a wage that can only provide an insufficient diet of too much carbohydrates (rice and few

vegetables), with little or no protein. If Dr. Cornwall's estimate is rather too high for people with ordinary means, Mr. Leith's is too low to maintain health. We cannot see how it is possible for a man in the position of a clerk to live on less than 6 annas a day, or 1 rupee a day for a family of husband, wife, and 2 children. We consider that a rupee a day is the minimum for food alone, and this does not include any other items of household expenditure.

Increased Wages and Food Production.—Side by side with the increase of wages sufficient to enable the people to maintain a decent standard of health and nutrition, means should be taken to increase the production of food. As agriculture is the mainstay of 300 millions of Indians, any improvement in the agricultural and dairy industry in India would mean the production of better crops and more food and the cheapening of the necessaries of life. Hence the great importance of giving attention to the improvement of every branch of Indian agriculture and the condition of the ryot, such as:

(*a*) Improving the seed and the soil, so as to obtain better and bigger crops.

(*b*) Improving cattle-breeding and fodder for cattle, so as to increase the quality and quantity of milk. Pure, fresh, and cheap milk is the greatest want in India.

(*c*) Manuring the land to increase fertility and improving agricultural machinery.

(*d*) Improving irrigation so as to be independent of seasons and rainfall.

(*e*) Helping the farmer by finding capital, by the Co-operative Credit System, and by teaching scientific farming and better methods of agriculture. With the increase of population, the growing demands for agricultural products, and the exhaustion of the soil through the manure being used for fuel purposes, the average yield of wheat per acre has diminished and is the lowest in the world. According to Professor Ganguli, it is only 12 bushels, as compared with 37 in Belgium, 32 in Great Britain and Germany, and 28 in Egypt.

(*f*) Reviving as far as possible the village life and its industries.

In reviewing the different measures we have briefly sketched here, it is well to remember that the social, sanitary, and poverty conditions in India are so bad that we may not accomplish much in the way of eradicating tuberculosis during the present generation. The various sanatoria would do spadework, and be used more as educational centres than healing places for some time to come. The early diagnosis and treatment on the part of medical men would go to increase the number of arrested cases and the value of sanatorium treatment. The difficulties of the caste system and the conservative habits of the people may stand in the way of a general adoption of sanatoria in India as they exist in England or Europe. The Indians as a rule are not inclined to seek treatment in a sanatorium far away, and the very name of 'sanatorium' may become a hindrance rather than a help. Hence the garden colonies or village settlements not far from a city, where a patient with early or suspected tuberculosis may go and live with his family under ideal conditions, open up a special field of usefulness and hold out a great promise in the treatment and prevention of the disease. A rise in the wages sufficient to maintain a decent standard of nutrition, and agricultural prosperity, are important means to reduce poverty and improve the vitality of the people.

Above all, attending to the health and nutrition of the children to-day would mean a stronger race and less tuberculosis in the coming generation. Therefore we would plead for the babies in arms who vainly suck the empty breasts of their half-starved mothers, for the boys and girls who go hungry and are partially deaf and blind from want of nourishing food, for the child-wives who fade away because of the heavy burdens a callous society has imposed upon their frail bodies. These economic improvements, the sanitary and agricultural reforms, the opening of new industries, village colonies, children's welfare, etc., bring us face to face with large vital issues which involve the very existence of the

Indian people as a nation. India is at the parting of the ways. Which is it to be—her going backward or forward, her degeneration or development ? May we hope that her present distress and suffering will be the means of evoking in her people a keen sense of sympathy and service, a new enthusiasm and courage to sweep away the apathy, the ignorance, and prejudice that have accumulated through centuries, and to institute measures for the social and economic regeneration which would increase the standard of health and well-being, and thus deal a death-blow to tuberculosis and all its associated evils. In this noble work the princes and the people, the municipalities and public bodies, the philanthropists and all well-wishers, should take a share in raising India from her present state. The Government will be required to do their part, and by patience and forbearance lead the people in the path of reform and efficiency. In conclusion, may I raise a word of warning against all panic legislation and violent propaganda by well-meaning but foolish enthusiasts, which would do immense harm to the cause of tuberculosis, as it has done in England and other countries. All hasty measures against the disease would create alarm and frighten the people, divide family and society, and bring unnecessary suffering to the consumptives who, from fear of boycott and ostracism, would suppress their disease till they are too far advanced to do any good, and thus defeat the very object we have in view—viz., the early detection and early treatment of the disease. Therefore, instead of filling the country with anti-tuberculosis societies, we would strongly advocate the formation of leagues of health, or health associations (as are formed in England), in every part of India, which would be the means of educating the people in all matters of hygiene and sanitation, of fostering a desire for social service, and at the same time of enlightening them on social evils and habits that lead to tuberculosis.

REFERENCES.

[1] and [2] *Rev. de la Tuber.*, March, 1925, vi., 177.
[3] *Amer. Rev. of Tuber.*, 1925, Abstracts, p. 37.
[4] Todd, *Med. Annual*, 1927, pp. 500-501.
[5] *Amer. Rev. Tuber.*, xiii., 1926, p. 129, August 15, 183.
[6], [8], [9], [17], [20], [24], [25], [26] and [27] 'Mutation Forms of the Tubercle Bacillus,' H. C. Sweany, *Journ. Amer. Med. Assoc.*, October 9, 1926.
[7], [15] and [16] *Amer. Rev. of Tuber.*, vol. xii., 1925, p. 358.
[10] J. S. B. Williams, *Brit. Med. Journ.*, 1911-12, p. 1582.
[11] Alex. Foulerton, *Brit. Med. Journ.*, 1912, i., p. 300.
[12] Edith J. Claypole, *Journ. Exp. Med.*, 1913.
[13], [14] Chemistry of Tuberculosis, Wells, De Witt and Long, pp. 107-108.
[17a], [18] *Amer. Rev. Tuber.*, vol. xii., 1925, p. 369.
[19] *Ibid.*, p. 368.
[21] *Ibid.*, p. 365.
[22], [23] *Ibid.*, pp. 371, 372.
[28] *Amer. Rev. Tuber.*, September, 1926, p. 331.
[29] *Johns Hopkins Hospital Bulletin*, March, 1925, pp. 36 and 175; *Journ. Amer. Med. Assoc.*, March 19, 1925, pp. 84 and 798.
[30] Petersen, Prot. Therapy and Non-Specific Resistance, p. 79.
[31] *Tubercle*, December, 1926.
[32] Chemistry of Tuberculosis, Wells, De Witt and Long, p. 83.
[33] *Ibid.*, p. 84.
[34] Zinseer, Infection and Resistance, p. 500.
[35] *Amer. Rev. Tuber.*, xiii., 1926, Abstracts, p. 56.
[36] *Journ. Immunol*, July, 1925.
[37], [38] Same as [30], pp. 130 and 131.
[39], [40] *Ibid.*, pp. 72 and 73.
[41] *Journ. Exp. Med.*, February, 1925. p. 65.
[42] Professor J. C. G. Ledingham, *Brit. Med. Journ.*, May 8 and 15, 1926, p. 816.
[43] Kundle, Hall, and Gerty, *Journ. Amer. Med. Assoc.*, October 23, 1926.
[44] Same as [30], p. 139.
[45] Zinseer, Infection and Resistance, p. 626.
[46], [49] David Campbell, 'Mechanism of Non-Specific Reaction,' *Brit. Med. Journ.*, December 13, 1924.
[47] *Amer. Rev. Tuber.*, July, 1926, Extracts, p. 23.
[48] Kolmer, Infection and Immunity, p. 647.
[50] *Ibid.*, p. 597.
[51] *Amer. Rev. Tuber.*, July, 1926, p. 324.
[52] Same as [30], p. 135.
[53] Gloyne, 'Principles of Immunity,' *Tubercle*, v., 1923-24, p. 319.
[54] Zinseer, Infection and Resistance, p. 145.
[55] *Ibid.*, p. 500.
[56] *Ibid.*, p. 321.

[57] *Ibid.*, p. 639.
[58] Krause, *Amer. Rev. Tuber.*, July, 1926, p. 294.
[59] Pritchett, *Journ. Exp. Med.*, February, 1925.
[60] *Edin. Med. Journ.*, March, 1926, pp. 164 and 168.
[61] Tulloch, *Tubercle*, vi., p. 106.
[62] H. C. Sweany, *Med. Journ. and Rec.*, March 18, 1925, p. 329.
[63] Drolet, *Amer. Rev. Tuber.*, x., 1924, p. 280.
[64] Austrian, *Tubercle*, vi., 1924-25, p. 29.
[65] *Brit. Journ. Tuber.*, xix., 1925, p. 67.
[66] Home Hospital, *Amer. Rev. Tuber.*, x., p. 639.
[67] Ford, 'Tuberculosis and Family History,' *Tubercle*, December, 1925.
[68], [69] 'Tuberculous Infection in North-East Minnesota,' *Amer. Rev. Tuber.*, August, 1926.
[70] 'Bovine Tuberculosis in Children,' *Tubercle*, vi., 1924-25, p. 45.
[71] Aas, *Lancet*, April 8, 1922, p. 205.
[72] McCarrison, *Brit. Med. Journ.*, February 21, 1920.
[73] Sir James Goodheart, Harveian Oration, 1912.
[74] Debré, *Tubercle*, October, 1923, p. 95.
[75] Austrian, *Tubercle*, vi., 1924-25, p. 29.
[76] Armstrong, *ibid.*, vi., 1924-25, p. 564.
[77], [78] Baldwin, Zinseer, Infection and Resistance, p. 232.
[78a] E. Lange, *Zeit. fur Tuberk.*, xl., 1924, p. 241.
[79] McNeil, *Amer. Rev. Tuber.*, October, 1926, p. 454.
[80] Penfold, Supplement, *Med. Journ. Australia*, i., 1924, p. 252.
[81] Armstrong, *Amer. Rev. Tuber.*, August, 1926.
[82], [83] Petersen, Protein Therapy, pp. 131-136.
[84] Stewart, *Tubercle*, January, 1927.
[85] Cooper, *Journ. of Lab. and Clin. Med.*, April, 1926.
[86] Kutz, etc., *Tubercle*, v., 1923-24, p. 552.
[87] Batty Shaw, *Brit. Med. Journ.*, December 26, 1925.
[88] Bezançon, *Amer. Rev. Tuber.*, ii., Abstract, p. 94.
[89] Archibald and Brown, *Journ. Amer. Med. Assoc.*, April 23, 1927.
[89a] *Amer. Rev. Tuber.*, November, 1925, p. 245.
[90] Würtzen and Holten, *Tubercle*, v., p. 93.
[91] Webb, Pulmonary Tuberculosis, Fishberg, p. 471.
[92] *Amer. Rev. Tuber.*, November, 1925, p. 217.
[93] Adams, *Tubercle*, February, 1927.
[94] Riviere, *ibid.*, v., 1923-24, p. 369.
[95] Tidey, Compression of the Lung in Treatment of Pulmonary Tuberculosis, 1927.
[96] Bach, *Tubercle*, October, 1926, p. 17.
[97] Sir Henry Gauvain, *Proc. Roy. Soc. Med.*, xx., April, 1927.
[98] Strandberg, *Tubercle*, January, 1927, p. 186.
[99] Greene, *Annals of Otol., Rhinol., and Laryngol.*, xiii., 1924, 193.
[100] Sir St. Clair Thompson, *Lancet*, May 7, 1927, p. 963.
[101], [102], [103] Fishberg, etc., *Therapeutic Gazette*, February 15, 1927.

[104], [106] Forssner, *Amer. Rev. Tuber.*, xiii., Abstracts, p. 14.

[105] Forssner, *Acta Gynæcol. Scandinav.*, iii., 1925, 256.

[106a] *Tubercle*, June, 1925, p. 437.

[107] Ewart, *Proc. Roy. Soc. Med.*, September, 1923.

[107a] Tuberculosis, Bacteriology, Pathology, and Laboratory Diagnosis, by Baldwin, Petroff, and Gardner, p. 217.

[108] McCollum, Newer Knowledge of Nutrition, p. 384.

[109] Cowell, *Brit. Med. Journ.*, July 31, 1926, p. 187.

[110] Sutton, *ibid.*, April 16, 1927, p. 740.

[111] Appleton, Newer Knowledge of Nutrition, McCollum, p. 391.

[112] Rowlands, *Lancet*, September 27, 1924, p. 675.

[113] Mellanby, 'Diet and Disease,' *Brit. Med. Journ.*, March 20, 1926.

[114] Same as [108], p. 376.

[114a] Petersen, Protein Therapy, p. 80.

[115] *Ibid.*, pp. 400 and 401.

[116] *Amer. Rev. Tuber.*, September, 1926, Abstracts, p. 68.

[117] *Amer. Journ. Hyg.*, iii., 1923, 71.

[118] *Amer. Rev. Tuber.*, 1924, x., p. 296.

[119] Bushnell, Epidemiology of Tuberculosis.

[120] Filipinos, *Amer. Rev. Tuber.*, xii., 1925, p. 308.

[121] Sir John Robertson, *Proc. Roy. Soc. Med.*, March 23, 1926.

[122] Drolet, *Tubercle*, v., 1923-24, p. 234.

[123] Rosenfeld, *Brit. Med. Journ.*, November 13, 1926, p. 901.

[124] Wilkinson, *ibid.*, June 4, 1927, p. 1029.

[125] Framingham, *Amer. Rev. Tuber.*, 1925, xii., pp. 308-309.

[126] *Brit. Med. Journ.*, August 8, 1926, p. 261.

[127] Guy, Medical Officer, November 6, 1926.

[128] Riviere and Sir Henry Gauvain, *Tubercle*, vi., 1924-25, p. 615.

[129] M. Moine, *Brit. Med. Journ.*, May 7, 1927, p. 845.

[130] Cherry, *Med. Journ. of Australia*, 1925, i., p. 581.

[131] *Amer. Rev. Tuber.*, x., p. 639.

[132] 'Economics of Public Health,' Freemantle, *Brit. Med. Journ.*, August, 26, 1922, p. 341.

[133] Report on Malaria in Bengal, by Dr. C. A. Bentley, 1916, p. 11.

[134] Tuberculosis in India, by Dr. A. Lankester, pp. 123 and 124.

[135] Report on the Prevalence of Tuberculosis in Bombay, 1915-16, by Dr. N. V. Dhavale.

[136] *Modern Review*, April, 1926.

[137] Dr. E. Muir, *Indian Medical Gazette*, July, 1926.

[138], [139] Lengthening of Human Life in Retrospect and Prospect, by Irving Fisher.

[140] *King George Medical Magazine*, Lucknow, June, 1926.

[141] *Med. Journ. and Record*, March 18, 1925.

[142] Sir Leonard Rogers, *Brit. Med. Journ.*, February 7, 1925.

[143] Sprawson, 'Tuberculosis in India,' *Tubercle*, iv., 1922-23, p. 481.

[144] Cornwall, *Madras Medical College Magazine*, January, 1923.

PULMONARY TUBERCULOSIS

ITS ETIOLOGY AND TREATMENT

PART I

CHAPTER I

INTRODUCTION

'The wisest, happiest of our kind are they
That ever walk content with Nature's way.'

WORDSWORTH.

'Go forth under the open sky
And list to Nature's teachings.'

BRYANT.

Tuberculosis from Ancient Times.

TUBERCULOSIS is a universal disease, found in every part of the earth, in every race of man, and in every historical age. It was known by various names among all the ancient civilized nations. The earliest medical writings of the Greeks present an unmistakable picture of tuberculosis. References to its ravages are found in the cuneiform tablets among the remains of Babylon.[1] It was known among the Egyptians many centuries before the Christian era. Bones of the Egyptians as seen in the museum of the Royal College of Surgeons, London, and skeletons of Egyptian mummies examined by Dr. Derry. (3000–2000 B.C.) and Elliot Smith (1000 B.C.) give evidence of the presence of tuberculous disease in those remote times.[2] Sir Armand Ruffer demonstrated tubercle bacilli in tissues in mummies from the Herst collection at Cairo, belonging to the twentieth dynasty or so.[3] Old Biblical allusions as early as 1500 B.C. are now

understood to refer to tuberculosis. Mention is also made in the Talmud about the disease occurring among cattle.[4] Consumption is mentioned in *Atreya Samhita*, the oldest existing work (at least 1000 B.C. if not more) on Indian medicine. In the works of Charaka and Susruta, the Indian physicians of classical fame, we find a more or less detailed account of the disease, its complications, and treatment of patients with animal food, ghee (clarified butter), and goat's milk.[5] Hippocrates[6] (460 B.C.) describes it as a febrile disease occurring mostly between the ages of eighteen and thirty-six, and as due to some constitutional defect which he called 'phthisical diathesis.' Though he does not mention its being contagious, Socrates, his contemporary, and Aristotle believed in its communicability. Aretæus (250 B.C.), who in common with many ancient physicians associated it with emphysema, believed in the efficacy of sea air and sea voyages for its cure. Celsus, 300 years later, recommends a milk diet, a change of air, and a sea voyage from Italy to Egypt. Galen (A.D. 130 to 201) follows Charaka and Susruta in advocating fresh goat's milk with salt or honey, a residence in a warm climate and in the highland of Phrygia.[7] Pliny speaks of sea voyages as being a popular remedy for phthisis in his time. Rhazes describes several varieties of consumption, and other Arabian physicians, like Avicenna and Serapion, follow the lines of Galen and his followers in treating the consumptive patients with ass's or goat's milk, and in addition give syrup of poppies to alleviate cough. After the Arabian period we pass over a space of many centuries when medieval medicine remained more or less dormant in Europe. Then came the Renaissance in countries bordering the Mediterranean, when medical knowledge revived chiefly in countries like Italy, France, and Spain, where exaggerated views concerning the contagious character of consumption were given credence, and most stringent laws were enforced against the spread of the disease and its victims. In Spain a law of compulsory notification of phthisis by the doctors was passed in the reign of Philip V. (1700 to 1724). The Grand Duke of Tuscany[8] passed a similar law in Florence, Italy, in 1754,

in spite of the attitude of its College of Physicians, who did not agree with him as to the contagion of phthisis, and who sent a report to that effect when he asked that body to support his views. In 1782 King Ferdinand of Naples went further and passed severe edicts with regard to the isolation of consumptives and the disinfection of their premises and belongings. The physicians were fined 300 ducats for failing to report cases of phthisis, and were given ten years of banishment for the second offence. The unfortunate consumptives were placed with or without their consent in hospitals for incurables, from which it is said that a great majority never escaped. What was the result? In Florence the laws, after being in vigorous force for thirty-nine years, had to be repealed by the Grand Duke Pietro Leopoldo as being 'a cause of bitterness, dissatisfaction, and vexation.' The Neapolitan government continued the policy of repression till 1809, when they began to doubt of its efficacy; the majority of the medical faculty when consulted by the health authorities decided against contagion, and after 1848 the laws became unworkable and 'sank into oblivion and decay.' Is there any evidence that these preventive measures had helped to reduce the death-rate of consumption? Dr. A. L. Pierson,[9] visiting a Neapolitan hospital in 1834, observed that some of the best informed Neapolitan physicians estimated the deaths from consumption at one-fourth of the whole mortality. Drs. Spattuzzi and Soma,[10] after making a complete investigation of mortuary returns of Naples about 1860, found that one-sixth of all the deaths was due to consumption, while in 1863 Dr. de Renzi,[11] the historian of Italian medicine, marvelled greatly that the city of Naples should be as liable to consumption as either London or Paris.

Such extreme views of the contagious character of phthisis, so prevalent on the Continent in the eighteenth and which died down in the nineteenth century, found no support in England. As early as the seventeenth century Richard Morton (1689), the author of *Phthisiologia*, a work which was in great repute for a hundred years both at home and abroad, attributed consumption to some derangement in the blood.

Sibbald,[12] writing about the frequency of the disease among the Scots peasantry in the seventeenth century, connected it with bad food, strong drink, and excessive toil. The English physicians in the early nineteenth century attached great importance to diathesis and morbid constitution as predisposing to tuberculosis. Dr. Benjamin Rush (1808) and Sir Thomas Watson[13] (1836) did not believe in contagion. Hughes Bennett,[14] the introducer of the cod-liver oil treatment, strongly held that tubercle was the result of errors of nutrition, while Walshe attributed it to failure of digestion and chyle formation. In 1867 Dr. William Budd expressed the view that tubercle was a true zymotic disease, and seven years later Hermann Weber read a paper before the Clinical Society 'On the Communicability of Consumption from Husband and Wife.' The opinion held by the medical profession could be roughly gauged, as when in 1883 the British Medical Association, through the Collective Investigation Committee, sent out to its members a series of questions as to whether consumption was contagious; out of 1,178 replies, 778 were given in the negative, and only 261 were affirmative, while 39 were doubtful. Even Laennec, the inventor of the stethoscope, concluded from his past experience that tuberculosis was not usually contagious. Flint,[15] as late as 1873, says: 'The doctrine of the contagiousness of the disease has now as hitherto its advocates, but the general belief of the profession is in its non-communicability.'

Returning to the Continent, Rokitansky, from a vast experience, formulated the law of the phthisical habitus—a small heart in a long, narrow chest, dyscrasia of the blood favouring pleuritic and other exudates, a delicate structure of the arterial walls and of the skin. Then came Virchow, who founded the modern cellular pathology in direct antagonism to humoral pathology and blood dyscrasia of the ancients. Villemin in France, Cohnheim and Klebs in Germany, made experiments on rabbits and guinea-pigs to prove the communicability of tuberculosis from one animal to another, and threw out suggestions of a virus from without as the cause of tubercle. While the professional views were swaying between

constitution and contagion, Robert Koch, in March, 1882, announced at the Berlin Physiological Society his discovery of a bacillus in human and bovine tubercles, which seemed to confirm the views of infection held before in doubt. Under the spell of the brilliant work of Koch and the French school various remedies to destroy infection were set on foot all over the civilized world, and bacteriology opened up a vast field of experimental research to prove the microbe origin of disease.

The Prevalence of Tuberculosis at the Present Day.

At the present day tuberculosis is widely distributed in every part of the earth, in every race and climate, among the rich and poor, the old and young, male and female, and man and animal. It prevails in all civilized lands, in all the capitals and chief cities of Europe, of Asia, Africa, America and Canada, Australia and New Zealand. In Europe it is reckoned that almost every human being is affected with tuberculosis at some part of his life. It is most fatal of all infectious diseases, and is responsible for about a seventh of the world's total mortality. More than half its victims fall in the very height of manhood and womanhood. Once called the White Plague, from its being chiefly found among the white races, it has spread among almost all the dark inhabitants of the world, and has well-nigh decimated some of the primitive races by its ravages. It is widely prevalent in India, Burma and Ceylon, Japan and China, in the West India Islands, in the coast districts of Mexico, Chili, Peru, Ecuador, among the North American Indians, the native races of the Southern Pacific, among Alaskans, negroes in the United States, in the French colonies, in Algeria, (formerly) German South-West Africa, East Africa, Gold Coast, Melanesia, Philippine Islands, Egypt, Syria, and Palestine. (Fishberg: 'Tuberculosis and Immunity,' *New York Medical Journal*, September 12, 1914). Unknown a few years ago, it is now found in countries like Persia, Greenland, and Lapland. Though the disease is said to be free in great mountain ranges and elevated table lands, it is now found

on high elevations like the Rocky Mountains, Le Plaz in Mexico (11,000 feet), Highlands of Switzerland, Alpine resorts, Beluchistan, and Kashmir and Nepaul in the Himalaya range. It is just as serious among the Esquimaux and the Laplanders as among the negroes of the Congo State, or the Kanakas of the New Hebrides. In fact, so wide and general is its distribution that no race or country is free from its devastation or possesses any natural immunity against the disease. Its trail is seen in every part of the habitable globe, in almost every child living under civilized conditions, and in every organ and structure of the body. No wonder so universal a disease involving the lives of millions of people has commanded the serious attention of both the medical profession and the general public. Two general observations may be summed up at this preliminary stage: (*a*) Tuberculosis is intimately connected with civilized life. Plants growing in their natural soil, such as the potato, wheat, and the vine, are free from disease, but when brought under cultivation they become subject to it. The cattle on the mountains and in the fields, the wild beasts in the forests, are free from tuberculosis; but bring them into houses, coop them in stalls and boxes, confine them in menageries, they die wholesale of consumption. So with primitive man. As long as he lived a free nomadic life he was more or less free from disease; but as soon as he began to put on clothes and build houses he stepped into a new environment. Clothes made the skin sensitive to external influences, and thus man was deprived of Nature's protection. If tropical diseases be the outcome of flies and insects loaded with bacterial and protozoal organisms, it is easy to understand that the skin, which is Nature's first defence, when softened by clothing, has opened the door to disease. The very life under civilized conditions deprived him of the immunity he enjoyed while he lived in the open air. (*b*) Tuberculosis is a product of our social and economic conditions. Disease is simply an expression of man's failure to adapt himself to a new environment. The progressive changes in the evolution of man, from pastoral and agricul-

tural to commercial and industrial life, were marked by an increase of wealth and comfort on the one hand and an increase of responsibilities and cares on the other; as civilized man further extended his conquests and widened his sphere of commercial enterprise into other countries, great upheavals took place in his physical and moral environment for which he was not prepared. It is this failure to meet new conditions and adapt himself to successive changes that has brought about social and economic evils which have accumulated with each generation. In his pursuit of wealth and pleasure, ease and comfort, man has departed further and further from Nature and natural modes of living. Towns have attracted the country people, and factories have become filled with men, women, and children. The cultivation of the land has been more and more abandoned; towns have become overcrowded. Competition has followed on the heels of commerce, and with it poverty and alcoholism. Factory life has turned men and women into machines, and has broken up the family through its members having to work late and long to obtain often a bare livelihood, and industrial diseases have increased in number and variety. Thus the empire has grown at the expense of the health of the people, and civilization has become hopelessly mixed up with poverty and wealth, struggle and competition, slums and overcrowding, drink and degeneration.[16]

The Problems that Confront Us.—This brings us to the consideration of the vast and complex problems that surround any enquiry as to the incidence, the treatment and prevention of tuberculosis. It is interesting to find that man at a certain stage of his evolution, when confronted with the mysteries connected with the origin of life and disease, has come to develop the doctrine of spontaneous generation and then of the germ theory of disease and of contagion. These evolutionary ideas can be dimly traced in the philosophies of India, Greece, and Rome, down to the Arabian period and the Middle Ages. The speculations of the past ages crystallized later on into systems of thought which were replaced in time by science in the nineteenth

century. With the growth of experimental research evolved the idea of specificity in the causation of disease. It is for us to examine how far experimental knowledge can be applied to elucidate the vital processes carried on in the human body, and how far disease can be interpreted in terms of micro-organisms. If medicine in the past has been influenced by the authority of the philosophers, we are no less dominated by the dogmas of the experimentalists. The gross mysticism that governed medicine in the early Christian era and before has been replaced by the rank materialism of the present day. If speculative systems vitiated the results of clinical observations of the Ancients, are we not equally in danger of being biassed by our scientific research and specialism which may have no eye beyond sense and reason, and no place for intuitions of the mind and the inner vision of the spirit? Be this as it may, we consider that the theory of infection is a phase in the evolution of ideas that may be replaced by something broader-based when seen by the light of a wider knowledge. More than a generation has passed away since Koch made his epoch-making discovery. The measures taken against the contagion of tuberculosis have not produced such a reduction in its morbidity as his followers had expected. We are now beginning to see that the foundations of tuberculosis lie deeper than the presence of tubercle bacilli, and that if man is ultimately a spiritual being, the mental, moral and spiritual factors have an important bearing in the causation and the cure of the disease. Side by side with its parasitic origin, the problems of tuberculosis are seen largely involved in the social, economic, and industrial life of the people, and in this enlarged outlook social reconstruction has become the dominant idea in the beginning of the twentieth century. Besides, the improved well-being of the people, which has brought about a large reduction in the consumption mortality, has helped to shift the interest from specificity to social environment in the campaign against the disease. Now that the great European War has come to an end and the civilized world intends to carry out

a better social order, it will find that the open-air movement has already prepared the ground for a constructive programme. For it has been the pioneer movement in showing the folly of crowded towns and congested cities, and the importance of God's fresh air and the open country, in building up a healthy and vigorous life.

To Sum up our Contention.—Life is one. Mankind is one. Micro-organisms are the product of environment. Disease is interrelated in the defective or the altered state of the blood, hence diseased conditions are within us and not outside. We carry within us the potentialities for good or evil. Life is manifested by resistance. The object of the open-air treatment is to renew and strengthen all the vital forces of the body. Behind microbes there lie ten thousand activities of the endocrine glands and metabolism, and behind these again lie the operations of the mind and the spirit which man can control. When the mind is girt with peace there is harmony, equilibrium, stability within. This is why the Great Physician healed disease by bringing peace within. The civilized man has lost this secret of health. The multiplicity of his duties and responsibilities have filled him with care and anxiety which have disturbed his calm and peace of mind so necessary for the healthy functioning of every organ of his body. The open-air treatment has taught this precious lesson, that it is only by going back from the bustle and excitement of the city life to the calm communion with Nature that man can regain his lost peace and health.

There are two ways of curing the evils of tuberculosis. As I write, it is spring-time. I see the old withered leaves of the beech in front of my study window are still clinging tenaciously to the old tree. While the driving rain and wind and snow of the past winter have failed to strip them from the branches, the sap is slowly rising, and the young shoots which are bursting into life are quietly displacing the brown leaves in a hundred places till the tree stands dressed in living green. So the evils of tuberculosis will not be cured by injection treatment or by any violent efforts

to destroy infection, but by the gentle flow of life and vital energy surging through the weakened frame of the patient when he is brought under the open-air treatment where the influence of fresh air and country life and of rest of body and mind ensures the arrest of the disease. Tuberculosis is mainly the expression of hunger—for clean air, clean food, clean surroundings, and clean mind. And only on these four corner-stones can a palace of health be built for suffering humanity for the cure and prevention of tuberculosis—yea, for all disease.

REFERENCES.

[1] *Tuberculosis Internationale*, June, 1914.

[2] G. E. Smith and M. A. Ruffer, 1910, 'Pott'sche Krankheit an einer Ägyptischen Mumie,' *Zur historischen Biologie der Krankheitserriger.*

[3] Medical Contributions to the Study of Evolution, by T. G. Adami, p. 16.

[4] *Tuberculosis Internationale*, June, 1914.

[5] See translated works of Charaka and Susruta, *Charaka Samhita* and *Susruta Samhita.*

[6] Translation of the works of Hippocrates, by Adams.

[7] *Tuberculosis Internationale*, June, 1914.

[8] A Medico-Literary Causerie, *Practitioner*, July, 1898, p. 54.

[9] *British and Foreign Medico-Chirurgical Review*, xlv., p. 112.

[10] *Practitioner*, July, 1898, cited above.

[11] *Storia della Mediciana Italiana*, p. 512.

[12] Contributions to the Physiological Theory of Tuberculosis, by Charles Creighton, p. 2.

[13] The Causes of Tuberculosis, by Louis Cobbett, p. 50.

[14] Charles Creighton, cited above, p. 4.

[15] Epidemiology of Tuberculosis, by George E. Bushnell.

[16] Pulmonary Tuberculosis and Sanatorium Treatment, by C. Muthu.

CHAPTER II

THE ETIOLOGICAL SURVEY OF TUBERCULOSIS

'Physicians consider that when the cause of a disease has been discovered they have also discovered its cure.'—CICERO.

'In this world there are so few voices and so many echoes.'—GOETHE.

THE writer has been actively engaged in open-air sanatorium work ever since 1899. Looking down the long vista of twenty-two years one gets an insight into the various problems of tuberculosis which have presented themselves from time to time. The physician working in an open-air institution has this unique advantage: his daily fight with tuberculosis brings him into living contact with every phase of the disease. The worker in the pathological laboratory who deals mostly with dead material and that far away from the arena of the disease, the specialist in the consulting-room who sees the patient away from his surroundings, have not the opportunity to follow up every case of tuberculosis or to examine its various phases of development in the same patient and at different times. But the sanatorium physician who keeps the patient under his observation day by day, week by week, and month by month, has abundant opportunities to study the disease at first hand at every stage from beginning to end and to put every theory and every remedy to practical test, hence his experience is invaluable. Mere coming daily into contact with patients is not enough. A wide philosophic outlook, a sympathetic interest in his charge, a keen intuition born of long observation and experience, an aptitude for appraising the values of various experimental and clinical factors—these qualifications are necessary to complete the value of sanatorium work.

Though a vast amount of literature has been written on tuberculosis, and a large army of workers is engaged in the field of research in almost every part of the world, we cannot

say our knowledge of the disease is in any way complete. Many problems connected with tuberculosis still remain obscure, and are waiting to be solved. What is tuberculosis? How far is it an infectious, hereditary, or constitutional disease? How does the tubercle bacillus enter the human or animal organism? How far is its presence in the body an indication of disease? What is the histogenesis of tubercle? Why should the disease exhibit such a variation in different persons? Can any reliance be placed in the treatment by injections and vaccines? Does one attack of tuberculosis confer immunity to a person? Has a child favourable or unfavourable prognosis for having been born of tuberculous parents? Does tuberculosis in a child confer immunity when it reaches the adult or old age? What is immunity, and how is it produced? Can resistance be raised by exposure to tuberculosis? Is a race better or worse for being afflicted with tuberculosis? To these and many similar questions we cannot honestly give a definite or satisfactory answer for the present. The more closely we examine these questions the more we are confronted with a diversity of expert opinion concerning every one of them. While some regard tuberculosis as an infectious disease, others believe it to be the product of social and economic conditions that prevail under civilization. Thus we are brought face to face with the views of two opposite schools. The old or contagious school, fortified by the teaching of pathology and bacteriology, believes that tuberculosis is a specific disease caused by the implantation of tubercle bacillus. The new or constitutional school, moving with the spirit of the times and strengthened by the recent advance of such sciences as biology, higher physiology, biochemistry, epidemiology, psychology, sociology, and economics, affirms that man's environment and his social condition form the chief factor in the causation of tuberculosis. The one believes that the morbific agent is introduced from without, and the other as caused by constitutional disturbance produced from within.

The arguments of both the schools will be presented in

the next few chapters, meanwhile the writer's long experience in sanatorium work has led him to arrive at the following conclusions:

1. The germ theory of tuberculosis has not satisfactorily explained all the problems of the disease. The presence of tubercle bacillus is not a decisive factor in the development of tuberculous processes.

2. We have made too much of microbes and too little of man in the causation of tuberculosis, which more truly lies within the body than outside. There is no valid proof that the widespread prevalence of the disease is brought about in the majority of cases by its contagious character.

3. Tuberculosis is a disease of civilization, of vicious social and economic environment, of poor and deranged nutrition —in fact it is a deficiency disease affecting the body metabolism, the condition of the blood, and the vitality of the system.

4. Morbid processes produced in the body by impaired nutrition and metabolism favour the development of pathogenic organisms which therefore follow and do not make pathological conditions. It is man that through his environment speaks the last word in the causation, the continuation, and the cure of tuberculosis.

5. Tuberculosis is not a definite entity. It is a blood dyscrasia, a deranged metabolic process which at first is physiological and temporary, and easily cured by Nature, but which if allowed to persist becomes pathological when it manifests clinical symptoms.

6. The only sure way of arresting or eradicating the disease lies in bringing about a radical improvement in the social, economic, and industrial welfare of the people. No remedy that does not alter their living conditions can hope to cure or prevent the disease.

The crux of the whole problem of tuberculosis falls upon the question of its etiology. The two schools above referred to—the specific and the social school, the seed and the soil school—differ absolutely in the causation of the disease. The one believes that tuberculosis is primarily an infectious

disease caused by the conveyance of tubercle bacilli from one person to another through the atmosphere or tuberculous food, and the only way to eradicate the disease is by destroying the sources and channels of microbe dissemination. The other maintains that it is mainly a disorder of nutrition, a diathesis brought about by poverty, worry, and bad hygienic conditions of civilization, and the only right way to deal with the disease is by improving the social and economic conditions of the people. Between the contagionists and constitutionalists there is a large body of moderates who believe that tubercle bacilli get implanted in a soil already weakened by poor and insanitary conditions. The attitude of the moderates, though plausible, is a camouflage, and tends to confuse the real issue. Either tuberculosis is a disease caused from beginning to end by tubercle bacillus, or it is pre-eminently a constitutional disease. According to the former view the seed makes the soil, the constitutional diathesis is the result of bacterial infection, while according to the latter the strumous or scrofulous diathesis is a primary condition which, instead of being caused by the toxin of tubercle bacilli, is the result of bad living and poor nutrition. These two etiological factors call forth two divergent ways of treatment.

The first would aim in destroying infection by notification, isolation, segregation, and injection. The second would concentrate all efforts in strengthening the constitution and increasing the vital powers of the patient. Much of the confusion, the uncertainty, and the vacillation that exist at the present time in the fight against tuberculosis is due to the profession in not having a clear conviction as to the etiology of the disease and in trying to do homage to both the specific and the social cause at the same time. We must decide whether tuberculosis is an infectious or social disease. We cannot have it both ways. If it be an infectious disease every measure of inoculation, injection, and antiseptic treatment would be both essential and successful. But while believing in contagion we cannot consistently swing round and attack poverty, alcohol, bad housing, low wages, and

other social evils. So we come back to the main enquiry—Is tuberculosis primarily an infectious or insufficiency disease? Is it due to contagion or constitutional disturbance, to bacterial infection, or to some biochemical deficiency in the blood and tissues? A correct understanding or knowledge of the cause of tuberculosis is absolutely necessary for successful treatment and prevention. It is time, therefore, that we lay aside every bias and prejudice and set out to explore every avenue in the light of present knowledge, and make a searching investigation of all the factors that lie behind this great plague which claims its victims by millions all over the world. The tendency of the present day is simply to echo the catch-phrases, the old shibboleths, the worn-out opinions of others. We need fearless voices who, unmoved by current tradition and thought, would think and seek for themselves the truth, and having found it would proclaim it fearlessly at any cost or sacrifice.

CHAPTER III

THE GERM THEORY OF TUBERCULOSIS

The germ theory of tuberculosis claims our attention first. How does the tubercle bacillus enter the body? Pathologists are not agreed as to the chief mode of infection. For many years pulmonary tuberculosis was believed to be caused by the inhalation of tubercle bacilli. Koch, and after him Cornet, Flügge, and many others, maintained the inhalation theory. Koch went so far as to believe that tuberculosis of intestinal origin, even in children, was rare. But Von Behring, Chauveau, Nocard, believed in the intestinal origin, and Calmette,[1] Guérin in France, Whitla, Symmers[2] in this country, proved by experiments that the digestive tract was the commonest source of pulmonary infection. Theodore Williams and, more recently, Sir Thomas Oliver,[3] also maintained these views. Now the pendulum seems to be swinging back to the inhalation theory which is supported by many authorities, including McFadyean, Cobbett, Griffith, etc. Not only the question of the relative importance of the respiratory and intestinal routes of entry still remains unsettled, but a further confusion is caused by the fact that what is inhaled may be swallowed, and what is swallowed by experimented animals may be regurgitated and inhaled into the trachea and the lungs.

While Cornet and Flügge believed in the inhalation theory, the former, with Koch, after making experiments in guinea-pigs, demonstrated that pulverized tuberculous sputum was the chief source of infection. Flügge, however, denied this, and, after also making experiments in guinea-pigs, came to the conclusion that the majority of cases of infection occurred in the act of sneezing and coughing. Leaving this controversy to be settled by the followers of these two savants, we may say with Chapin[4] that we are

not warranted in assuming that either Cornet's dust or Flügge's droplets under natural conditions is the chief mode of infection. As Cumming says (*Journ. Amer. Med. Association*, April 17, 1920), our efforts to control the disease by the restriction of spitting and coughing have not given results that inspire a high degree of confidence, while when specimens of air-dust were obtained by drawing air through water by means of a suction pump and the deposits were injected into guinea pigs, only one injected animal died, but not from tuberculosis. Romer,[5] a careful worker in the field of tuberculosis, after weighing all the evidence for both inhalation and intestinal theories, sums up by saying that none of the given channels of entry of tubercle bacilli is alone sufficient to solve adequately all the complicated problems of tuberculosis, and that there is some mode of transmission of the disease with which we are not yet acquainted. If we cannot satisfactorily answer such a simple question as how the lungs are infected or how infection takes place, can we logically presume the presence of infection at all in the majority of cases? What is infection? How loosely and indiscriminately the terms 'infection' and 'contagion' are used in connection with tuberculosis. They cannot be synonymous with 'invasion' or 'contamination,' for it is well known that even pathogenic organisms may invade the tissues without necessarily producing disease. Inman[6] truly says that the mere recovery of micro-organisms does not necessarily denote that it is an affecting agent, nor is the part they play to be established even when their virulence is proved by inoculation. The mere presence of a micro-organism in connection with a disease does not prove that it is the cause of that disease.

Congenital Infection.—Is the child infected through the mother? Prenatal infection is so rare that it can be considered a negligible factor. The possibility of infection through the egg has been proved experimentally, but, as Cobbett[7] observes, this is a different thing from showing this mode of infection occurs under natural conditions. Post-mortem records do not support the view that congenital

tuberculosis is common. It is recognized that tuberculosis is seldom seen in the calf. Auche and Chambrelant,[8] after a careful investigation, concluded that transmission from mother to fœtus through the placenta is rarely observed. Naegeli and Ungermann ('Causes of Tuberculosis,' by Cobbett) found no tuberculosis in newborn infants. The evidence of tuberculosis grows six months after the child is born. Clinically there is no evidence that tubercle bacilli enter the fœtus through a tuberculous mother. Since there is a decided history of heredity in so many cases of consumption, it follows that what is inherited is a constitutional weakness, a vulnerability of tissue rather than bacterial infection from the mother.

Conjugal Infection.—There is no evidence, at least in the majority of cases, that living with tuberculous husbands brings about a greater incidence and mortality among their wives, or *vice versa*. In fact, we have to face this anomaly, that while there is a high death-rate from consumption among Sheffield grinders and the tin-miners of Cornwall, there is a correspondingly low death-rate among their wives and children.[9] The statistical figures brought forward from time to time to prove conjugal infection are neither conclusive nor convincing. All such statistics ignore the possibilities of chance association and the difficulties of tracing and diagnosing early cases. Mere presence of tuberculosis among married people, or among those living under the same roof, no more proves that one has infected the other than cases of gout, rheumatism, or toothache, occurring among members of the same family or in the same house, prove they are infectious. The universal prevalence of tuberculosis among civilized countries and its commencement in childhood render worthless all statistical conclusions that bear upon conjugal infection. For, if practically every civilized being is tuberculous, a very large number of cases of the disease must occur among husbands and wives independent of any infection, and if tuberculosis begins in early childhood, no one can say when and how infection took place. Before we can form an opinion as to whether

marital relationship influences the occurrence of tuberculosis, we must prove that its observed frequency is greater than the expected frequency.

Fishberg,[10] writing from an experience of hundreds of poor consumptives in New York, finds that the disease in both husband and wife is exceedingly rare. Pearson[11] uses the rarity of marital infection as an argument against the infectiveness of phthisis. He and Elderton point out that in tuberculous diathesis there is a great deal of assortative mating in the marriage of persons of a like constitution. They further state that those who dogmatically assert that the association of tuberculous husband and wife beyond the random proportions can only be due to the influence of infection must be prepared to admit that insanity in possibly a more marked degree than tuberculosis is transmissible between husband and wife. After a careful and exhaustive study of the question, Dr. Charles Goring[12] came to the conclusion that 'the correlation of infection of tubercular disease from association in marriage is both negative and insignificant—that is to say, healthy individuals are not, upon the evidence of our data, infected by marriage with tubercular mates.' In our twenty-two years of sanatorium records we cannot find that even in one-half per cent. of cases the husband or wife infected the other. In the author's book on 'Pulmonary Tuberculosis' (1910) he gives three remarkable cases of working men's wives who nursed their consumptive husbands all through their fatal illness, but who, nevertheless, did not contract the disease. Many such cases of negative evidence have since multiplied.

Contact Infection.—Of late there has been a great cry about the spread of tuberculosis by contact infection, and about the necessity of close observation and examination of suspect cases in the same family. When we look into the question impartially, we find that in the majority of cases there is no more proof of contact infection than there is in conjugal infection. True, cases have been reported where direct infection seems possible among poor families living in the same room as the consumptive in an advanced stage whose

expectoration has been allowed to dry and be scattered about the place under the most unhygienic conditions. Against this must be laid the observation of Haldane, that the wives and children of phthisical tin-miners never seem to be affected with the disease although occupying the same room as the affected men who never go to a hospital, but sit at home and expectorate sputum loaded with tubercle bacilli. Barwise noted the same thing among gritstone workers in Derbyshire, and Collis among stone-masons.[13] All these facts seem to show that, in spite of a terrible incentive to contagion, people escape contracting tuberculosis, either because tubercle bacilli in these cases are incapable of producing tuberculosis, or that the soil is stronger and more resistant than the seed. Again, as Krause[14] says, the widespread tuberculization of the human being during the first few years of life seems to weigh decisively against the opinion that intimate contact with open cases of consumption is the common method of infection. There is no doubt that social and economic causes play a large part in the incidence of tuberculosis among the poor in lodging and tenement houses who are brought together by stress of poverty and unemployment. The writer, while working in North London, often found that in seasons of unemployment and distress the working-class families had to seek smaller accommodation, and move from three-roomed to two, and from two to one-roomed house, owing to sheer inability to meet the former rent and other household expenses. So that if there is a greater incidence of tuberculosis among the one-roomed than the two or three-roomed house, it is more likely not due to greater contact as believed in some quarters, but that one-roomed habitation indicates a greater poverty than the two-roomed, and greater poverty in the two than the three-roomed house. That conditions of poverty have a direct bearing on the incidence of tuberculosis is ably brought out by Dr. Sandilands,[15] Medical Officer of Health for Kensington, who discusses the problem of house infection from notification of phthisis between 1910 to 1913, where with equal population in the north and the south of the district the

deaths from phthisis were three times as numerous, and the number of notifications more than four times as numerous in the north where there is greater poverty and greater congestion than in the south. When successive occupants develop consumption, it is more likely due to their being subjected to similar environment, as damp and ill-ventilated houses, poverty, want, poor nutrition, etc. Dr. Sandilands sums up his enquiry by saying that 'the figures and facts advanced, and sometimes accepted as proof of house infection, do not in themselves prove anything of the kind. They are worthless because they are prepared without regard to the possibilities of chance association, and in some instances more worthless still because they ignore the fundamental point of the date of onset of the disease. And so houses are put forward as the cause of phthisis in lodgers who have come there moribund for a few months on their way to the infirmary.' That house infection is possible in a small number of cases may be proved, but a great number of multiple instances occurring in the same family or in the same house are more likely due to chance association, as in the case of the married couple, to being subject to similar conditions of environment—social, economic, hygienic, etc.—and not the least to hereditary influence. Pearson and Goring have suggested that the heredity figure for phthisis is definite and fairly high, and that children brought up under the same roof, living in the same environment of poverty, bad hygiene, are likely to develop conditions that predispose them alike to tuberculosis. Sir Hugh Beevor, in a paper on 'Rural Phthisis and Insignificance of Case-to-case Infection,' published a table showing similar phthisis death-rates in each decade for three decades, 1861-70, 1871-80, 1881-90 per 10,000 living at ages 25-45 in eighteen Norfolk rural sanitary districts. These figures indicate a constancy in rural phthisis. How can we account, asks Beevor, for a family likeness so remarkable for that local constancy which is so regular? and adds: 'This uniformity in the history of rural phthisis strikes me as most cogent evidence of the insignificance of case-to-case infection; the

rates are far too regular for so variable a factor to be the determining factor.'

Aerial Infection.—The time-honoured view that the air is the chief vehicle for the conveyance of infectious diseases is not generally accepted at the present day. Only a few years ago yellow fever and malaria were regarded as typical air-borne disease. Enteric fever, diarrhœa, dysentery, and even typhus and plague were believed to be due to atmospheric contamination by sewer gas, or to bacteria given off freely from the fæces, or to exhalations from breath. Pasteur's theory of putrefaction caused by floating particles in the air, and Lister's carbolic spray to keep aseptic the atmosphere of the operation-room, lent support to the theory of aerogenic infection. Years ago Tyndall demonstrated that expired air is sterile. Pathogenic organisms have never been found living in the atmosphere. Careful research has shown that the air exhaled by consumptives during ordinary quiet breathing is free from tubercle bacilli. Winslow and Robinson, after making experiments to determine the extent of general air-infection in a room by droplet infection, conclude that there is 'no basis for a belief that tuberculosis or any other disease is contracted to an appreciable extent through the inspired air,' and that their conclusions are 'in harmony with the conviction now generally gaining ground that aerial infection is a minor factor in the spread of zymotic disease.'[16] Thompson and Price,[17] after treating together certain zymotic diseases in the ordinary wards of a hospital, came to the conclusion that scarlet fever, diphtheria, german measles, and mumps were not air-borne. Typhoid, cholera, and dysentery are treated in general hospitals without danger of extension to other patients. More striking than the observations of Thompson and Price are the results obtained at the Liverpool Fazakerley Hospital,[18] where infectious cases, such as scarlet fever, diphtheria, chicken pox, whooping cough, erysipelas, measles, tuberculosis, mumps, were treated together with non-infectious cases, and no steps taken to disinfect the nose, throat, or skin by such measures as swabbing, syringing, or spraying the patients, and yet not one of the non-

infectious cases became infected. These results confirm the experiments of Bournville, Richard, and notably Grancher and Roux,[18] of the Enfantes-Malades, who conclude that infection is by contact and preventable, that aerial transmission is non-existent. Even with regard to smallpox Collie thought that aerial transmission was a fallacy and that it was due to contact infection. Surgeons operate with success even in the unhygienic atmosphere of a tenement. Wright's brilliant researches in the study of the physiological processes existing in wounds, and his reliance on the natural defences of the body in place of antiseptics, show what a long way we have travelled from Lister.

Experience of Consumptive Hospitals and Sanatoria.—If pulmonary tuberculosis were a contagious disease, consumptive hospitals and sanatoria would be hotbeds of infection, and there would be evidence of the physicians, nurses, and others engaged in them being infected by the disease. But what is the clinical experience? There is a remarkable history of immunity from consumption among the staff of sanatoria and consumptive hospitals both in America and Europe. At Falkenstein, during ten years, 225 non-tuberculous friends accompanying patients have stayed at the sanatorium—many have stayed for six months—and no case of infection has been observed. In America, Trudeau[19] says that at Saranac Lake Sanatorium no nurse, attendant, or servant has ever contracted consumption. C. Theodore Williams,[20] from statistics taken from the Brompton Hospital for Consumption, London, down to the year 1909, showed that long before the discovery of the tubercle bacillus, and before any precautions were taken to prevent the transmission of the disease, no case of infection occurred among the hospital staff, numbering several hundred, not a few of whom lived in the hospital for a number of years continuously. Similar statistics are available for hospitals in France and Germany. Saugmann,[21] after collating data from many sanatoria in various countries, comes to the conclusion that tuberculosis is extremely rare among those who are engaged among consumptives. Speaking from our own experience,

we have examined samples of air from the rooms and chalets of our patients, and the result has always been negative. Among those employed in our sanatoria during the last twenty-two years—medical men, matrons, nurses, attendants who have daily come into contact with the patients—there is no proof that even a single one has been infected by such contact. So that there is no evidence that workers in consumptive hospitals or sanatoria contract the disease as a result of attending their patients.

Infection through Food. — Does infection take place through the food? Meat is seldom the means of carrying infection. Tuberculosis rarely affects the muscles of which the meat is chiefly composed. Even if it does it has little chance of thriving in it on account of the acid secretion produced by muscular activity, and also if any stray bacilli be found in the muscle it would be destroyed by cooking. Moreover, studying the customs of the European Jews, we find that if tuberculosis is conveyed by the ingestion of meat, it ought to be rare among the Jews of Eastern Europe, who strictly carry out the dietary laws which require that carcases of all animals killed for food should be subjected to a very minute and searching examination. But the fact is that tuberculosis is more common among them than among the Jews of Western Europe, who in a very large number of cases pay no regard to those laws.[22]

Infection through Milk.—Can milk set up tuberculosis in man? The writer attended a Tuberculosis Congress held in London, 1901, when Koch made two announcements which startled those gathered at the meeting. (1) Human tuberculosis differs from the bovine and cannot be transmitted to cattle. If by human tuberculosis is meant infection with the human type of the bacillus which is found in an overwhelming majority of tuberculous cases in man, it is proved conclusively that Koch was right. (2) He went on to say that bovine tuberculosis is so rarely transmitted to man that the danger of infection from that source may be safely ignored. Here again he was right in the case of adults, since numerous investigations have not established the infectious-

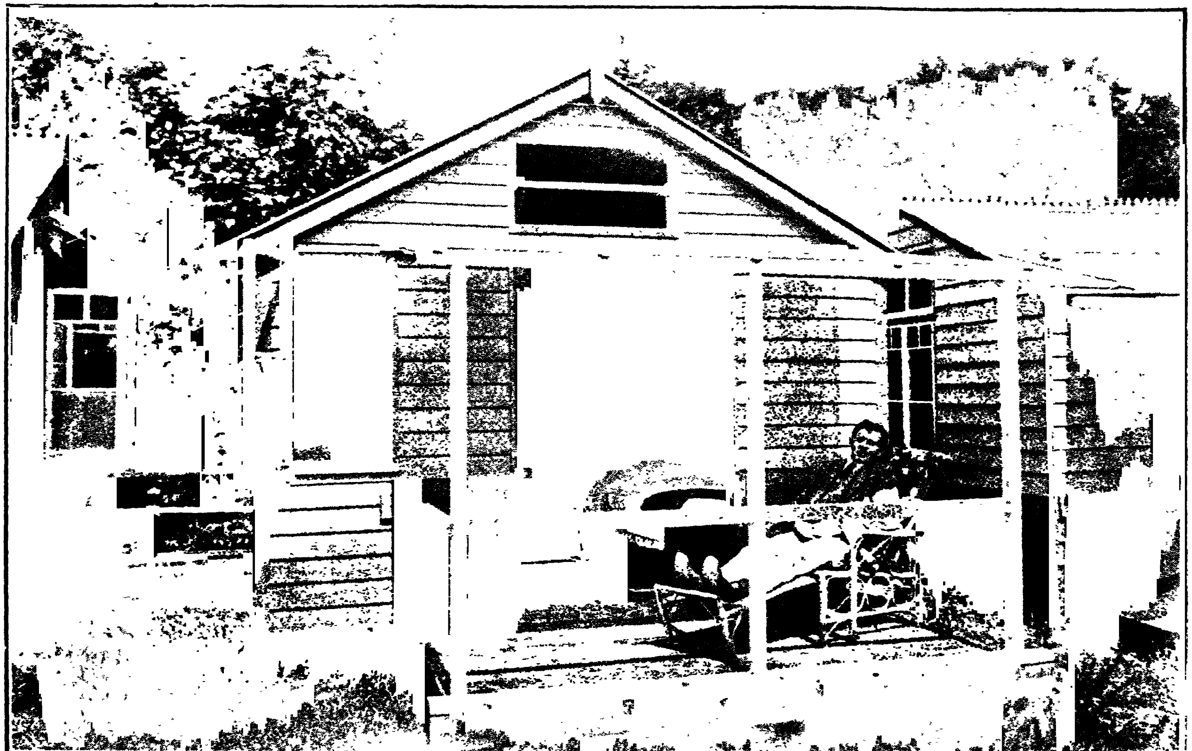

FIG. 2.—A SLEEPING CHALET AT MENDIP HILLS SANATORIUM.

To face page 24.

ness of the bovine virus in man. But there is a great difference of opinion as to whether children can be infected by tuberculous milk which is the chief source of bovine bacillus. Koch held that even in children the danger of infection from milk is quite subordinate to that from human beings. If tuberculosis in children is caused by the ingestion of cow's milk, how is it that poor children who drink less milk have more tuberculosis than those of the well-to-do classes who drink more? And how is it that in countries like Japan, China, India, where children are breast-fed for many months and where little or no cow's milk is drunk, tuberculosis is widely distributed among the population including the children? Kitsato says that the use of cow's milk for feeding infants is unknown in Japan and that native cattle do not suffer from tuberculosis, and yet the mortality from primary intestinal tuberculosis is greater (30 per cent.) there than among Europeans and Americans (25 per cent.), and that many children who drink tuberculous milk never get tuberculosis.[23] In India, besides the children being breast-fed, owing to the dearness of cow's milk, very little of it is used among the poor in many parts, and condensed milk is substituted because it is cheaper and keeps good for a longer time; besides, tuberculosis among the cattle is very rare, and yet the writer[24] during his recent visits to India found that tuberculosis is alarmingly increasing, especially in crowded cities like Bombay, Calcutta, Madras, etc. So also Heymann[25] finds in other countries: 'Greenland: No tuberculous milk, yet phthisis very common, and tubercular meningitis one of the commonest causes of death in children. Asiatic Turkey: Raw milk is never drunk even by adults, children breast-fed for two years; tuberculosis of all kinds very common and very virulent. Roumania: Children breast-fed for a long time; tuberculosis very rife even in regions where there is no milk at all. Egypt: Milk so dear that it is a luxury to the rich; tuberculosis very common, especially among the Negroes and Berbers.'

Take again some Negative Evidence.—Professor Adami[26] made experiments on some calves which were fed with tuber-

culous milk for five months. He says: 'These calves injected in January with tuberculin and in July giving negative results. The interval of more than five months between the injecting of the tuberculin and their failure to react at the end of that period makes it reasonable to believe that so far these feeding experiments have demonstrated that milk supplied from tuberculous cows has not proved infectious when fed to the calves.' So hundreds of children drink tuberculous milk and yet are not affected with consumption. In the course of German investigation from 1905 to 1909 there were examined 69 instances where tuberculous milk was consumed by 151 children and 109 adults, out of whom only two of the children (youngest of the family) were affected and they merely had a mild adenitis; they had taken the milk for a year and a half-year respectively, from cows with virulent disease of the udder. Ungermann,[27] in Germany, found that among 687 consumers of milk from cows with udder tuberculosis 280 were children. The majority of the consumers enjoyed good health. In only two cases was infection with a bovine strain of bacillus proved and a suspicion of infection in fourteen others. A well authenticated case is reported from New York, where a special herd of Jersey cows which had supplied all the children of the richest families for a number of years were found to be tuberculous, and the doctors who formed a committee to examine the children found that among those hundreds of children only one girl of thirteen showed any signs of tuberculosis.[28]

If there be any intimate connection between milk and tuberculosis in children one would naturally expect that the disease would have a greater incidence during the period when the children lived chiefly on milk, and become less and less prevalent when they are further removed from infancy. Whereas it is curious that tuberculosis is rare among infants during the first six months, and the further the child is away from the milk-drinking period the greater the incidence of the disease till the age of sixteen. Again, if cow's milk be the chief source of tuberculosis, there would be a high percentage

of bovine infection among children, but Park and Krumwiede,[29] of the New York Research Laboratory, in their study of the relative importance of the bovine and human types of tubercle bacilli, classified their own cases of tuberculosis and those reported by other workers, and found that out of 368 cases of tuberculosis among children under five years of age 292 showed the human type and only 76 the bovine type, which means that cow's milk cannot be the cause of infection in the majority of children under five years, unless we assume that bovine bacilli become changed into the human type within their system, which the pathologists deny at present. Clinically, Nietner[30] recognizes occasional infection by tuberculous milk, but considers such cases are comparatively uncommon. Koplik,[31] speaking of American children, says that bovine tuberculosis from milk cannot form over 1 to 2 per cent. Emmett Holt,[32] who made a special study of this question, says: 'Much stress has been laid upon tuberculous milk as a means by which children are affected. There is little pathological support to be found for the view that children often contract the disease in this way. . . . While infection from milk is possible, it is certainly entirely infrequent.' With such facts before us, gathered from different sources and different countries, how is it possible to believe that the wide prevalence of tuberculosis in children is caused by drinking cow's milk?

Report of the Royal Commission on Tuberculosis.[33]—This seems to be a fitting place to say a word or two on the report of the Royal Commission on Tuberculosis, which has been widely accepted both by the public and the profession. But all the arguments and clinical findings we have adduced do not support the Commissioners' view that tuberculous disease in children is conveyed by means of tuberculous milk of cows. While fully recognizing the honour and integrity of the Commissioners, it is questionable at the very outset how far it was wise to employ the same members as those of the first Commission. This is not done in a court of law, where the same jury are not chosen twice in trying the same case. The Commissioners would naturally enter

their task with a mind prejudiced with the old verdict they had brought, and which would subconsciously and unwittingly colour all their observations and findings. From looking over their report this was what seemed to have taken place. At the very beginning they made a mistake in discarding all inhalation experiments and confining themselves to feeding experiments. Next, when they found bovine bacilli, they at once jumped to the conclusion that they were derived from cow's milk, thus confounding the bovine type with the bovine source of infection. They had no warrant to infer that because they found bovine bacilli the disease was transmitted from the cow—*i.e.*, they have assumed the very thing they were called upon to prove. When we come to study the twenty-nine cases on which the Commissioners rest their proof of infection through cow's milk, we see that in fourteen the bacillus was of bovine type, in thirteen of human type, and in two cases both the bovine and human were found. So that leaving the two cases of mixed infection, all one could infer is that the human bacilli were found in nearly as many cases as the bovine type, but to conclude from such evidence that 'tuberculosis of childhood is to be ascribed to infection with bacilli of the bovine type' is, to say the least, very misleading. Again, there is no proof for their statement that the 'infection with bacilli of the bovine type is transmitted to children in meals consisting largely of the milk of the cow.' As Dr. Vincent has pointed out, there is not a line of evidence that the children whose cases they investigated ever received cow's milk, tuberculous or otherwise. In one case, at least, of the fourteen which contained bovine bacilli, it was found that the child never drank fresh cow's milk at all, but was brought up on condensed milk. Even their injection experiments on animals did not produce lesions suggestive of spontaneous tuberculosis. While some animals escaped altogether having tuberculosis, in others they provoked morbid processes which were more of the nature of bacillary necrosis or of common pneumonia. Altogether the results of both their feeding and inoculation experiments are not convincing

to a critical observer, and have failed to prove what they assert—the connection between cow's milk and tuberculosis in infancy and childhood.

On the other hand, there is much evidence for the contention of those well able to speak from experience that it is not fresh milk, but the want of it, or improper feeding with cooked milk, that encourages the development of tuberculosis in children. The tragedy of the Great War in Central Europe has demonstrated, not in one or two, but in thousands of instances, that rickets and tuberculosis were the outcome not of ingestion of milk, but the want of it, and of chronic starvation, underfeeding, and malnutrition. In civilized countries the majority of the infants are not breast-fed, but are brought up on condensed milk, or patent, or some artificial food, which is neither sufficient nor nutritious. Pure milk, especially human milk, contains proteins, lactose, and other ingredients easily digestible in the infant's stomach, and certain vitamines and antigens which cannot be determined by chemical analysis. Besides, fresh milk contains a great many lactic organisms which promote healthy digestion, and prevent any putrefactive changes from taking place in the alimentary canal. But cooking, pasteurizing, or sterilizing milk tends to destroy some of its vital properties, to interfere with the work of lactic organisms, and favour the growth of colon and other putrefactive bacteria. Two things follow: In the presence of putrefactive organisms any harmless tubercle bacilli present may take on pathogenic action. The products of pyogenic bacteria have an irritant action on the walls of the intestines, bringing about their catarrhal state, and favouring the absorption of toxins and causing disorders of the bowel and stomach. The result is, that the natural biochemical processes become pathological, digestion is rendered difficult, nutrition impaired, and malnutrition leads to such diseased conditions as scrofula, rickets, and tuberculous diathesis.

But the children, ill and diseased from being brought up on unsuitable or insufficient food, begin to thrive as soon as

they are judicially fed with cow's milk, and treated in the fresh-air condition of a home or the wards of a hospital. Dr. Ralph Vincent,[34] from his own long experience at the Infants' Hospital, London, has proved that sick children who were brought up on pure milk did extremely well. He could not establish any relationship between the consumption of raw milk and the incidence of tuberculosis. So that when facts collected from all sides are studied carefully and impartially, they furnish no proof that, while infection of milk is now and then possible, the general prevalence of tuberculosis among children is caused by the ingestion of cow's milk.

REFERENCES.

[1] Calmette, *Ann. Past.*, 1905, pp. 617 618.

[2] Sir William Whitla and Professor Symmers, *Lancet*, 1908, ii. 135.

[3] The Causes of Tuberculosis, by Cobbett, p. 142.

[4] Charles V. Chapin, The Air as a Vehicle of Infection, *Journal of the Amer. Med. Association*, February 7, 1914, p. 424.

[5] Romer, M. Brauer, Schröder, and Blumenfeld's Handbuch der Tuberkulose, 1914, i., p. 247.

[6] Inman, *Lancet*, 1912, i., p. 975.

[7] Cobbett, The Causes of Tuberculosis, p. 121.

[8] *Ibid.*, p. 132.

[9] *Ibid.*, p. 96.

[10] Fishberg, Pulmonary Tuberculosis, p. 110.

[11] Pearson and Elderton, A Second Study of the Statistics of Pulmonary Tuberculosis : Marital Infection, 1908.

[12] Goring, On the Inheritance of the Diathesis of Phthisis and Insanity : Studies in National Deterioration.

[13] Pulmonary Tuberculosis, by Fishberg, p. 99.

[14] Krause, *Amer. Rev. of Tuberculosis*, September, 1919.

[15] Sandilands, House Infection in Phthisis, *Public Health*, May, 1914.

[16] Charles V. Chapin, *Journal of the Amer. Med. Association*, February 7, 1914, p. 424.

[17] Thompson and Price, *Lancet*, June 13, 1914.

[18] *Nursing Mirror*, July 24, 1920, pp. 282-283.

[19] Trudeau, Consumption and Civilization, by John Huber.

[20] C. Theodore Williams, *Brit. Med. Journal*, 1882, p. 618.

[21] Pulmonary Tuberculosis, by Fishberg, p. 110.

[22] Tuberculosis and the Jew, by W. M. Feldman, *Tuberculosis Year Book*, 1913-14, p. 51.

[23] Adaptation and Tuberculosis, by J. Adami, *Brit. Med. Journ.*, May 27, 1905.

[24] *The Practitioner*, June, 1915.

[25] *Brit. Med. Journ.*, Epitome of Current Literature, January 9, 1909.

[26] Adami and C. F. Merton, Report on Observations made upon the Cattle at Outremont.

[27] James Millar, Pathology of Tuberculosis, *Tuberculosis Year Book*, 1913-14, p. 121.

[28] Robert Mond, Sterilization of Milk: Its Danger to Infants.

[29] Relative Importance of the Bovine and Human Types of Tubercle Bacilli in the Different Forms of Tuberculosis, by Park and Krumwiede, *The Journal of Medical Research*, September, 1912.

[30] *Lancet*, 1912, ii., p. 1342.

[31] *Johns Hopkins Hospital Bulletin*, 1913, p. 113.

[32] Holt, Diseases of Infancy and Childhood.

[33] Final Report of Royal Commission on Tuberculosis, p. 39.

[34] Vincent, *Lancet*, April 25, 1914, p. 1185.

CHAPTER IV

PATHOLOGICAL AND BACTERIOLOGICAL EVIDENCE OF TUBERCULOSIS

PATHOLOGISTS base their evidence of tuberculosis on diseased conditions of lymphatic glands and tissues, on the presence of tubercles and tubercle bacilli, and on post-mortem findings.

Lymphatic Glands.—What constitutes tubercular disease in lymphatic glands? Is it their enlargement or caseation, or their reproduction of disease by inoculation experiments, or their post-mortem appearance? Enlarged glands are not necessarily tuberculous. Glands may be enlarged in many other affections, such as struma, scurvy, chlorosis and anæmia, cancer and rickets. The enlargement in these conditions seems to show that it is due to some blood disorder rather than to bacterial infection. They may also be enlarged in diphtheria, rheumatism, syphilis, and diseases of the scalp. Adenitis of the bronchial glands is a frequent sequelæ of measles and whooping cough.

Glands may be normal and healthy, and yet may contain tubercle bacilli.

Weichselbaum and Bartel,[1] by means of inoculation of guinea pigs, demonstrated tubercle bacilli in the apparently normal glands of eight children who had died of one of the infectious fevers, and in whose bodies the most careful anatomical examination failed to find any tuberculous changes. Kälble[2] found tubercle bacilli in two cases in bronchial glands, which showed no histological changes whatever. Rosenberger[3] found that normal glands taken from non-tuberculous persons provoked tuberculosis when injected into guinea pigs. So have Eastwood and F. Griffith[4] recovered tubercle bacilli from apparently normal tissues;

on the other hand, they found that injections of emulsions of calcareous glands failed to produce tuberculosis, though they contained tubercle bacilli. Similar observations were made by Weber and A. S. Griffith.

The presence of tubercle bacilli in a gland does not determine tuberculosis in a child, and their absence does not mean there is no disease. Apparently the injection of healthy glands may produce tuberculosis or glands definitely tuberculous and containing tubercle bacilli may fail to produce the disease. Kelynack[5] affirms that many of the glands marked tuberculous are not tuberculous at all, and that in a considerable number of instances glandular enlargements in the neck of strumous children are due to streptococcal or other non-tuberculous infection from the throat, particularly through lymphatic channels of the tonsils, or arising from septic agents through the skin, the mucous membrane of the mouth and pharynx, or by way of decayed teeth. Mere reproduction of disease through the injection of gland substance does not prove infection any more than the spread of skin tissue in skin-grafting means that the integument is contagious. Emile Roux[6] found that, employing every care, not a single tubercle bacillus might be detected in the sections made from a caseous tubercle, and yet their injection into an animal caused disseminated tuberculosis. The very fact that the injection of healthy gland tissue or caseous material may cause tuberculosis in guinea-pigs suggests that tubercle bacilli are not necessary to produce tuberculous lesion, or that they grow out of caseous substance; and if injection of tuberculous tissue is more effective in causing tubercular disease, we must infer that diseased tissue is the cause of the spread of the disease rather than the micro-organisms.

Caseous nodules, as we have seen, may be incapable of producing tuberculous lesion, even though they may contain tubercle bacilli. If caseation is a pathological process induced by tubercle bacilli, one would conclude that the greater the number of bacilli the greater will be the caseation, whereas both in the mouse and the rat the presence of

a large number of bacilli go hand in hand with the absence of caseation. So, also, in the horse tuberculous lesion may be found without any tendency to caseation (Cobbett).

If tubercle bacilli control infection and tuberculous lesion, the severity of tuberculous disease will be in proportion to the number of bacilli, and there would be more bacilli found in acute and susceptible cases than in chronic and resistant animals. Whereas in most acute and generalized tuberculosis there may be a few or no bacilli present, and resistant animals, such as the rat, mouse, and the horse, may contain numerous bacilli. Evidently the difference in the character and the extent of the tuberculous lesion in man and animals is not due to the difference in the quantity of tubercle bacilli. As a matter of fact, both in artificially induced lesions and in clinical cases, there is no rule or relationship between the extent of tuberculous lesion and the number of bacilli found, in the same way that the number of meningococci found are not in direct ratio to the severity of the symptoms. Tubercle bacilli may be present for months and even years in a healthy animal without provoking tubercle or caseation. The intravenous and intraperitoneal injections of large quantities of tubercle bacilli prove fatal from general toxæmia rather than from bacterial infection. All these facts go to show that there exist other factors that control tubercle bacilli and tuberculosis.

Looking from a clinical point of view, we know that children may be riddled with enlarged glands and scrofulous disease without manifesting any clinical symptoms or being any the worse for their tuberculous condition. Enlarged glands tend to heal up spontaneously, and children affected by them get quite well. The post-mortem examination of adults who died of accident or some disease other than tuberculosis often gives evidence of large scars or slaty calcareous nodules and cicatricial foci in the lungs, showing great involvement of lung disease without manifesting any clinical symptoms during their lifetime. All these surely point to the physiological rather than the pathological

nature of the disease. Again, we find that enlarged glands are chiefly associated with a scrofulous constitution, poor physique, poverty, malnutrition, slums, overcrowding, etc., and when the children are removed from such unhealthy environment into the country and fresh-air life and are carefully fed and looked after, the glands subside and get well as the children improve in their general health—proving that they are the product of poor nutrition and unhygienic surroundings.

Post-mortem Findings.—Even post-mortem findings do not give any definite or conclusive evidence of tuberculous disease. Tuberculous glands in children may so completely heal up as to leave no trace of the disease either macroscopically or microscopically when examined at the post-mortem in adults. Why should the proportion of bovine infection in cervical gland tuberculosis vary from 26 per cent. in Germany, 41 per cent. in England, 44 per cent. in the United States, to 90 per cent. (Mitchell) in Scotland?[7] Is this disparity due to the difference in the proportion of the lesion caused by tubercle bacilli in various countries or to the difference in the conception of the workers as to what constitutes tuberculous gland? What is the pathological manifestation of a tuberculous gland or lung? Naegeli[8] of Zurich regards the peripheral, slaty, scar-like areas which he finds in 100 per cent. of lungs he has examined as tuberculous in nature, while Burkhardt places the figure at 91 per cent., Bouchard of Paris at 75 per cent., Lubarsch of Posen at 61 per cent.; but Beitzke of Berlin thinks it a mistake to put down all the scars in the lung as tuberculous in nature, and lowers the percentage of tuberculous infection to 58·2 in adults and 13·6 in children below fifteen years. Goerdler,[9] in supporting Beitzke, shows that disease processes other than tuberculosis can produce changes extraordinarily like those of tuberculosis, so that, as in the case of lymphatic glands during life, the discrepancy in the percentage of post-mortem findings among workers shows that they are not agreed as to what constitutes post-mortem evidence of tuberculosis.

Tubercle.—The centre of interest in the pathology of tuberculosis lies in the histogenesis of tubercle. Histologists are not agreed in their explanation as to the method of its formation or the origin of its various constituents. According to the bacillary theory of tubercle, it is the outcome of the reaction of the tissues to tubercle bacilli, which by their irritation of cells and intercellular substance provoke a proliferation of connective tissue, endothelial cells, and leucocytes which surround the micro-organism and form a nodule; this nodule degenerates in the middle, forming a homogeneous mass with giant cells containing tubercle bacilli at the periphery and nuclei in the centre.

Virchow, in his *Cellular Pathology*, considers that the connective tissue is responsible for the formation of tubercle. Baumgarten holds that the stimulating action of tubercle bacilli on endothelium of vessels and fixed cells of tissues renders them large and plump, converting them into epithelioid cells, and that the giant cells are formed by the multiple division of the nucleus (karyokinesis) without the protoplasm participating in the cell division. Metchnikoff has studied tubercle as part of his general doctrine of the phygocytic action of leucocytes on bacteria. He traces the development of epithelioid and giant cells from epithelial cells and further back to leucocytes. Borrel, who defends the histogenesis of Metchnikoff against that of Baumgarten, says that the leucocytes in the capillaries of the lung engulph the tubercle bacilli, and are first poisoned by them and then perish and fall into débris: that epithelioid cells grow out of this débris and the bodies of the bacilli, and that giant cells are formed by the fusion of the epithelioids. Weigert[10] interprets the giant cells of Langerhans as a partial caseous degeneration of cells in process of proliferation, while Kockel does not attribute any single mode of origin to the giant cells, but inclines to believe that in the liver at least they start from hyaline capillary thrombi and endothelial cells. While thus there is a difference of opinion as to the origin and significance of epithelioid and giant cells, they all have ignored the part played by the red cells—the predominant element in the

blood—in their theories of histogenesis. In the first place, we must recognize that experimental tubercles are not the same as spontaneous tubercles. One finds that the injection of Koch's bacilli does not always produce tuberculosis in animal experiments. Experimental tubercles present much diversity of character and are not the same as those found in the natural disease. It is remarkable that in the experiments made on animals by the Royal Commission on Tuberculosis it was found over and over again that after the injection of tubercle bacilli the animals were in perfect health or showed no tubercle after they were killed, and when tubercles were found they were irregular in outline, generally confluent and showed no tendency to be distinct from the surrounding tissue, or there were no epithelioid or giant cells, or even tubercle bacilli found in them.

Secondly, tubercles need not be produced by Koch's bacilli alone. In 1887 Galtier[11] produced tuberculosis by the intravenous and intraperitoneal injections of whey and cheese. In 1889 Pfeiffer cultivated a bacillus—which he named 'bacillus pseudo-tuberculosis'—from the tissues of a glandered horse in which he could find no micro-organisms of any kind, which killed white mice and guinea-pigs, and on intravenous injection in rabbits proved fatal within twenty-four hours. A few years afterwards a bacillus was isolated from samples of butter by Lydia Rabinowitsch, which was indistinguishable in size, form, and staining property from Koch's bacillus, and which when injected into the peritoneum of guinea-pigs produced tubercles, suppuration, and death. In 1897 Moeller found an acid-fast bacillus in Timothy-grass indistinguishable from the tubercle bacillus, and having like effects on rodents. Lubarsch confirmed Moeller's discovery and, after making a series of experiments, concluded: 'There can be no doubt that it is quite impossible to distinguish certainly, by histological and micro-parasitic examination, between the tubercles of the Timothy-grass bacillus and genuine tubercles.'[12] Another variety of grass bacillus was found in the excreta of cows, donkeys, and other herbivorous animals.

Thirdly, even non-bacterial substances can produce tubercle formation. Metchnikoff demonstrated tubercles by the injection of goose blood, H. Martin by the injection of fowl's blood in guinea-pigs. Wooldridge,[13] working in Ludwig's laboratory at Leipzig, injected a proteid substance taken from the thymus and testes of calves, and produced the same thrombosis and the same infarcts of the lung as found in the rabbits in the first week after injection of tubercle bacilli. Schmorl[14] confirmed Wooldridge after repeating his experiments, and thus rebutted Eberth's suggestion of the possibility of bacteria being accidentally mixed with the injected proteid. And even injection of wheaten groats in guinea-pigs by Rocht has produced thrombi and tubercles with giant cells. So we come to see that tubercles can be produced not only by Koch's bacillus, but by the large group of acid-fast bacilli which may be called saprophytes or pseudo-bacilli; or they may be caused by the injection of whey, butter, cheese, or even of protein taken from calves' thymus or wheaten groats. True, the tubercles produced by these various agencies may vary in histological character and in the effects produced in different animals. But so, also, as we have seen, tubercles caused by Koch's bacilli vary in their characteristics, constituents, and effects produced in different animals according to their susceptibility, resistance, and the dose injected. To classify some as true tubercles and others as pseudo-tubercles from the difference in their histology and structure is more arbitrary than scientific. There is no absolute structural type of a tubercle peculiar to any bacillus. There are many things, Creighton says, in the human tuberculous cadaver and as many more in the bovine which are never found in the inoculated rodent—things with which bacilli never had anything to do, although they are integral to the disease. Wooldridge's experiments on protein taken from the thymus, and Kockel's experiments[15] on wheaten groats, open up a wide field of suggestion (which will be amplified later on), that the effects of tubercle bacilli in producing tubercles is likely to be caused in virtue of their protein nature, and

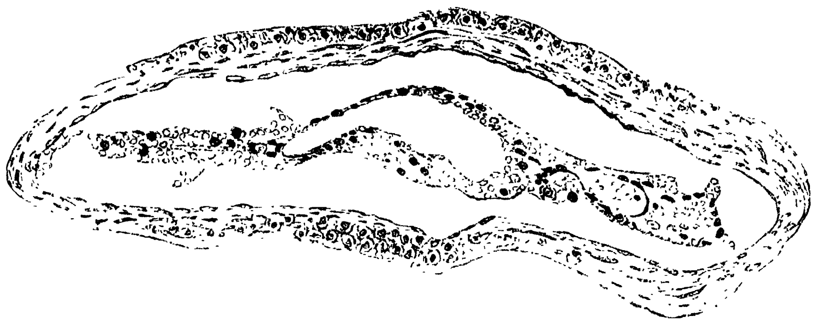

FIG. 3.—PULMONARY ARTERY, RABBIT'S LUNG, SEVEN DAYS AFTER INOCULATION.

Thrombus free in lumen, containing red blood corpuscles, threads of fibrin, leucocytes and nuclear chromatin dispersed between the threads of fibrin to make new nuclei.

(*Reproduced by permission of Dr. Charles Creighton.*)

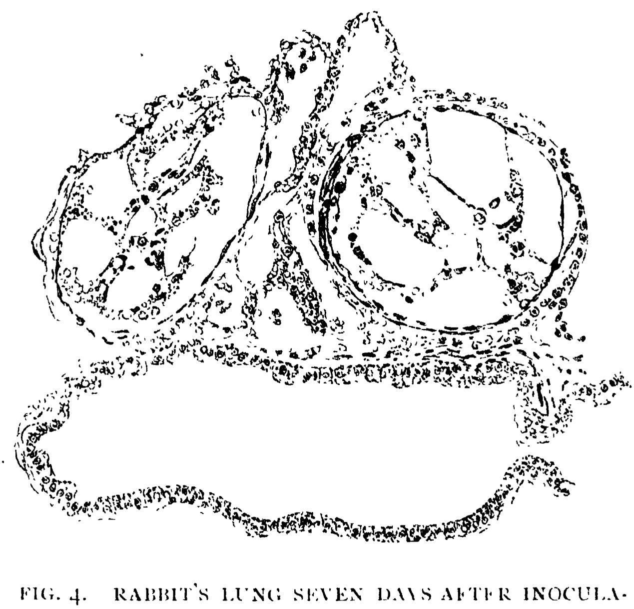

FIG. 4. RABBIT'S LUNG SEVEN DAYS AFTER INOCULATION.

Below, a bronchus; above, two sections of a pulmonary vein occupied by plasmodial new growth composed of threads of fibrin, leucocytes, and entire blood corpuscles or reduced to platelets and granules. Between the sections of brain are several compressed air-cells, their walls thickened and with fused masses of endothelial cells free in their cavities.

(*Reproduced by permission of Dr. Charles Creighton.*)

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that any other foreign protein may bring about a similar result under similar circumstances. Histologists have given such exclusive attention to the presence of tubercle bacilli, and to their pet theories concerning the formation of tubercle, that they have overlooked its most important source and constituent—viz., its hæmorrhagic origin and the red cells. The true explanation of tubercle formation, as Creighton[16] has pointed out, centres round the red corpuscles of the blood. Three stages in the process can be recognized:

(*a*) **Thrombosis.**—Lubarsch[17] at Posen found thrombosis of the pulmonary artery in some of the post-mortem cases of phthisis he had examined. Cornil found blocked bloodvessels as well as blood pigment, hæmatoidin crystals, and other evidences of extravasation in the track of the arteries entering the tubercles. Klebs[18] found in many of his old specimens that the vessels near to miliary tubercles were blocked by thrombi of that kind. Lorrain Smith has also pointed out the formation of thrombus, extravasation of red corpuscles, arrest of bacilli in the lumen of the capillary, and congestion and catarrhal pneumonia in the alveoli of the lungs. All experimental injections on animals—whether they are Koch's bacilli, some pseudo-bacilli, or some protein in the form of whey, cheese, calves' thymus, or groats—have one common effect, they seem to bring about an altered state of the blood and its coagulation in the vessels in the lung, liver, spleen, and lymphatic glands —which are organs concerned physiologically in the ordinary maintenance and renewal of red blood corpuscles. Forty-eight hours after injection experiments minute thrombi could be seen with the aid of the microscope, and at seven days the various thrombi could be seen *in situ* (see Figs. 3, 4, and 5). Among the experiments by the Royal Commission on Tuberculosis on two sets of rabbits, hæmorrhages could be seen up to five days. Chantemesse[19] describes thrombosed vessels with diseased walls as well as engorged capillaries 'from which the red corpuscles have escaped to infiltrate the surrounding substance.' Kolliker[20] gives an instance of red blood corpuscles being engulphed by protoplasmic cells in a small

hæmorrhagic focus from a case of rapid tubercular meningitis in a child. So many workers have noticed clots in the vessels as the earliest process in the formation of tubercle.

(*b*) **Extravasation.**—This thrombus leads in turn to stasis, extravasation, dissolution, and phagocytic reduction of red cells by the pulp cells of the spleen, the leucocytes of lymphatic glands, air cells and endothelial cells. From such infiltration, reduction, and assimilation of tissue cells and leucocytes an extemporized tissue is formed which is the beginning of a tubercle, the centre of which is a thrombosed artery. So that giant cells are simply blocks or thrombosed vessel with zones of blood granules or reduced remains of red cells of the thrombus. Epithelioid cells are formed by tissue cells with broken up or reduced red cells, the remains of bacilli if there are any, with broken chromatin grains forming nuclei.

(*c*) **Caseation.**—Such a hastily formed extemporized tissue of inert substance made up of disintegrated blood cells, and remains of phagocytes which have been destroyed by their very inclusion of red cells—all forming a granular or homogeneous mass—must break down as nature has intended and be disposed of. We shall go into the matter more fully in another place. Here we shall only point out that such a tubercle formation is more physiological than pathological, and explains the presence of large cavities and other signs of extensive destruction of tubercles found in the post-mortem of healthy persons who have died of injury or some other accident. The obliteration of bloodvessels is not, as held by the bacillary hypothesis, the consequence of nodular formation and caseation, but is the cause of it.

These facts put together seem to connect the tubercle formation with the thrombosed vessel caused by some toxic agent which results in the softening of the endothelium and dilatation of bloodvessels, congestion, stasis, thrombosis, hæmorrhage and extravasation of red cells which are engulfed by the various phagocytes and the formation of tubercle. The giant cells with marginal nuclei become

FIG. 5. A SOLITARY YELLOW TUBERCLE IN A BOVINE LUNG.

The island of caseous consolidation has formed around a thrombus of the pulmonary artery. In the angle between the vertical and horizontal branches of the artery, on the right, the structure contains several large giant cells, probably intra-alveolar. The area of consolidation is pervaded by dilated capillaries or small veins, and the groundwork of it is the air-cells in immediate contiguity with the thrombosed bifurcating artery. It is indeed a fair sample of the ordinary broncho-pneumonic island of caseation in the chronic phthisical human lung, with the peculiarity that it is solitary in the particular organ, and that its concentration round a blocked pulmonary artery is exceptionally clear.

(*Reproduced by permission of Dr. Charles Creighton.*)

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intelligible as blocks at certain bends of the vessels which are either dilated capillaries or small veins. Phagocytosis is not confined to leucocytes alone, but the pulp cells of the spleen, liver, and endothelial cells also take part in the process. Phagocyte cells are not directed against bacilli alone, but red cells, blood platelets, anything and everything that is foreign and inimical to nature which needs expulsion or destruction. The experimental tubercles may vary in their consistency and character in different animals. What is common to them all is thrombus, extravasation, formation of nodules and caseation. Such a rational theory of tubercle formation, which was first pointed out by Creighton, more truly explains the histological, pathological, and post-mortem findings, and the occurrence of hæmoptysis in early cases of tuberculosis.

Bacteriological Evidence.—The bacterial evidence of tuberculosis is chiefly based on animal experiments, and the part played by the specific character of tubercle bacilli in causing infection.

Animal Experiments.—Experiments made on animals have rather confused than clarified the evidence of infection. For artificial experiments are not, and cannot be the same, as spontaneous infection, because (*a*), in the first place, selecting susceptible animals, and taking them from their natural surroundings and cooping them in boxes and cages and feeding them artificially, would tend to bring about an alteration in their environment, to lower their vitality and predispose them to infection. Trudeau (*Evolution and Disease*, by Nash) found that rabbits inoculated with tuberculosis rapidly died if they were kept in a dark and damp place, while others inoculated in the same way, but allowed to run wild, usually recovered. (*b*) The feeding experiments are far more severe than is likely to take place under ordinary conditions. (*c*) The question of dosage is a very important factor in the success of experimental infection. One can succeed in infecting almost any animal, and can prove infection by any route if the dose of bacteria—even harmless ones—is large enough, and the mode of infec-

tion is severe enough. Watson Cheyne,[21] in experimenting with such a saprophyte as bacillus proteus vulgaris found that five to six million organisms injected beneath the skin did not produce any lesion, eight millions caused the formation of an abscess, while fifty-six millions produced a phlegmon from which the animal died in five or six weeks, and two hundred and twenty-five millions caused death in twenty-four hours. Studying staphylococcus aureus upon rabbits, he found that twenty-five millions caused an abscess, while a thousand millions were necessary to produce death. (*d*) Again, subjecting the timid and sensitive creatures to inoculation and other experiments would create a certain amount of shock to their system which would interfere with their physiological functions and paralyze the efficiency of their defensive mechanism. The writer has seen wild rabbits die from sheer terror when caught alive. It has been shown that fear, which is a form of shock, can cause paralysis of splanchnic nerves and more or less cessation of physiological functions which would render an easy entrance of micro-organisms into the system. Even the very process of injection of large quantities of bacilli or infected food would cause some degree of irritation to the delicate intestinal epithelium which would permit an easy absorption of bacterial or toxic substance. What can be the value of proof of infection obtained under such unnatural and artificial means?

(*e*) As a matter of fact, animal experiments have not succeeded in inducing pulmonary tuberculosis in experimented animals. Attempts to infect by feeding have not always been successful. Even subcutaneous injections may fail to infect animals, and if large doses of intravenous and intraperitoneal injections do prove fatal, death is more likely due to a general toxæmia than to tuberculosis. The very fact that different doses in different animals and different methods give different results shows that animal experiments cannot prove anything conclusive. (*f*) Experts themselves are not agreed in the results of their experiments. When several observers judge differently and come to different

conclusions from similar experiments, who is to decide? It may not be entirely their bias or their personal factor that causes them to disagree from one another; there may be difference in the technique, in the culture media, in the susceptibility of the animals experimented upon. Error may creep into the experiments in a hundred ways which would militate against arriving at the right conclusion. (*g*) Moreover, the presence of spontaneous tuberculosis in the animal would vitiate the results of all experiments. For no one can tell whether the tuberculosis from which the animal is suffering was caused by the experiments or from a spontaneous disease it already had. Experimental infection is no proof that it occurs spontaneously and in natural conditions in man. The hereditary transmission of tuberculosis can be brought about and proved by infecting the eggs with large doses of tubercle bacilli, but clinically we know that tubercle bacilli are not transmitted from mother to infant. (*h*) Even if it be possible to induce tuberculosis in animals in natural conditions, it does not prove that the results obtained from lower animals can be equally applied to man. Guinea-pig is guinea-pig and man is man, and it is impossible to bridge the tremendous gulf that separates man from the lower creatures in mind, intelligence, consciousness and personality by millions of years of evolution. He must be a bold materialist who can see no difference between a pound of flesh of a human being and a pound of flesh of a rabbit. Even here science declares emphatically that the flesh of animals differs from each other and that the very proteins which perform identical functions in different animals are not themselves identical, but differ from genus to genus, from species to species, and differ the more widely the further the several species are separated from each other in the evolutionary scheme.[22] And how much infinitely greater is the separation of animals from human beings endowed with such high moral and spiritual qualities. So that taking all these considerations we must conclude that we cannot rely upon laboratory experiments on animals

or draw any inference from their results as to what is likely to happen in the case of man.

REFERENCES.

[1, 2, 3, 4] The Causes of Tuberculosis, by Cobbett, p. 73.
[5] Kelynack, *British Journal of Tuberculosis*, October, 1915.
[6] Adami, *Brit. Med. Journal*, October 14, 1916.
[7] The Causes of Tuberculosis, by Cobbett, pp. 594, 595.
[8, 9] Shennan, 'Morbid Anatomy of Tuberculosis in Man,' *Lancet*, March 7, 1914, p. 675.
[10] Tuberculosis, by Cornet and James, 1904, p. 94.
[11] Physiological Theory of Tuberculosis, by Creighton, p. 121.
[12] *Ibid.*, p. 125. [13, 14] *Ibid.*, pp. 128, 129.
[15] Kockel, *Virchow's Archiv*, vol. cxliii., 1896, pp. 547-639.
[16] Physiological Theory of Tuberculosis, by Creighton.
[17, 18] *Ibid.*, pp. 217-219. [19, 20] *Ibid.*, p. 190.
[21] Pathogenic Bacteria and Protozoa, by Joseph McFarland.
[22] 'Medicine from the Chemical Standpoint,' by Garrod, *Lancet*, August 1, 1914, p. 283.

CHAPTER V

TUBERCLE BACILLI IN RELATION TO TUBERCULOSIS

Before proceeding to study the relation of tubercle bacilli with tuberculosis, it is necessary to make a brief survey of micro-organisms in general, to find out the part they play in the animal organism. Bacteria are unicellular organisms found practically everywhere in the vegetable and animal life, in the air we breathe, the food we eat, the water we drink, in the soil we tread, etc. A great majority of them exist as saprophytes and are harmless to man. Indeed, they are very necessary to everyday life, and serve man in countless ways. They cause fermentation, and help the baker, the farmer, the cheesemonger, the weaver, and the manufacturer. Their activities are beneficial in the making of bread, in giving flavour to butter and cheese, and aroma to wines and spirits, in softening meat, in forming vinegar, peat, coal, and in the manufacture of tobacco, indigo, linen, leather, and various other industries. They purify sewage, decompose animal and vegetable matter, and act as scavengers; they fertilize the soil, nourish the plants with food, and ripen fruit. They act as living ferments in the body, and take part in the physiological functions of digestion, assimilation, and excretion. Like enzymes in the animal organism they perform both catabolic and synthetic actions. They peptonize milk, split nucleic acids, convert amino-purins to oxy-purins, reduce metals, digest products of exudates, decompose proteins, deamidize amino-acids, setting free ammonia and leaving free fatty acid. Many soluble enzymes are found both in bacteria and in their reactions. They can produce rennin (as seen in their coagulating milk independent of any acid reaction) and catalase, liquefy gelatine; leucin, tyrosin,

and phosphoric acid are some of their autolytic products. They can synthesize from non-protein media the purins, phosphatides, and typical proteins containing aromatic amino-acids. Conradi[2] believes that in cultures even powerfully bactericidal substances are produced through autolysis of bacteria. In the lower bowel their presence in large numbers (it is reckoned they constitute about one-third of the bulk of the fæces) must surely be to synthesize the by-products to be utilized again in the animal economy. So that both in decomposing and building up for the use of the organism they must help nature very considerably. Prolonged life is impossible in the absence of saprophytic bacteria, since in their absence the formation of oxidizing ferments is so much reduced that auto-intoxication takes place.[3] In fact, we do not know the extent of their usefulness both in health and disease. Bacteriology has so persistently called our attention to their evil ways that we have ignored the fact that myriads of them render priceless service to man, and that life would cease to exist even for a day without their aid and co-operation. We have been so engrossed by the pathogenic character of the few that we have not cared to study the beneficent action of the great majority of bacteria.

How have they become pathogenic? In the process of evolution, we find that a few of them, from living as saprophytes outside the body, have taken to live first as saprophytes and afterwards as parasites within the body, and thus have acquired new characters by an alteration in their environment. In fact, all the characters of bacteria—their morphology, their virulence and pathogenicity, agglutinating properties, their pigment production and ferment reaction—can be more or less modified or destroyed by a change of environment. For instance:

They show Modification in their Type and Morphology.—Bacillus coli may take the form of diplococci or a dense network of branching filaments. Bacillus diphtheriæ may assume clubbed and branched or coccoid forms. Streptococci of scarlet fever grown on serum form rods closely resembling bacillus diphtheriæ. Tubercle bacilli in the

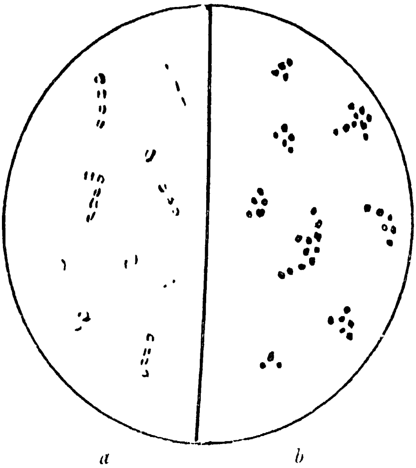

FIG. 6. COCCUS FROM B. ANTHRACIS.

(*a*) From the original colony from plain agar.

(*b*) From a later subculture on plain agar.

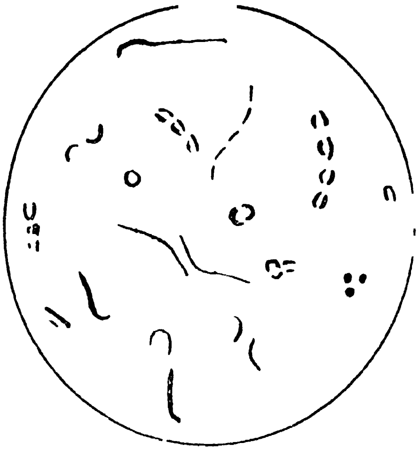

FIG. 7.—PASSAGE FROM COCCUS INTO BACTERIUM.

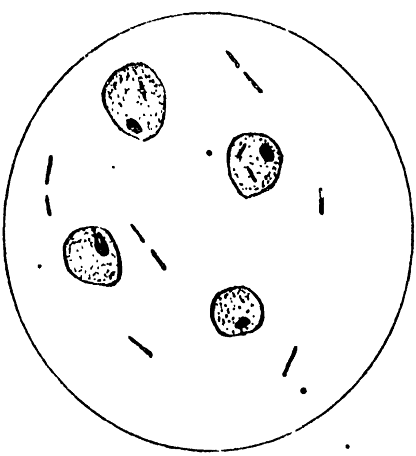

FIG. 8.—SPOROBLASTS AND BACTERIA.

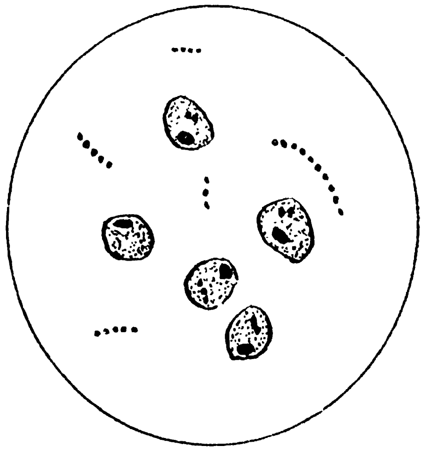

FIG. 9.—SPOROBLASTS AND STAPHYLOCOCCI.

(*After Young.*)

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presence of carbolic acid or creasote assume non-motile cocci or diplococci forms. Dr. Young,[4] in her cultural experiments, has seen both bacilli and cocci develop from sporoblasts, motile forms transformed into non-motile ones and vice versa, and a pink staphylococcus pass directly into a bacterium when subcultured on glucose agar, the coccal form growing again when transferred to the plain agar (see Figs. 6-9). She also obtained from human tubercle extraordinarily waved and curled filaments in three and four day old cultures on plain agar. By passage through a calf paratyphoid bacillus Flugge becomes changed into Gaertner bacillus. It is well known that Madame Victor Henri, by exposing a culture of anthrax bacilli to ultra-violet rays, has converted them into cocci. Arkwright found bacillary forms of meningococci in old cultures.[5]

They show Modification in Virulence.—Harmless saprophytes, such as pneumococci, micrococci catarrhalis, bacillus coli acquire power so that they produce pneumonia, meningitis, and enteric fever; on the other hand, virulent pathogenic organisms, such as Klebs-Loeffler bacillus, the meningococcus and bacillus typhoid, become changed and deprived of their power to produce diphtheria, meningitis, and typhoid fever. So, also, highly virulent streptococcus aureus has become converted into less virulent streptococcus albus and *vice versa* (Andrews and Gordon). Thiele and Embleton found that bacillus mycoides, a harmless organism living in the garden soil, has, by changing its environment, acquired all the characters of anthrax bacillus. Bacilli anthrax lose their virulence when grown at temperature 35° C., or in a medium to which carbolic acid has been added. Bacillus coli, when grown in water, loses virulence and power of producing indol; so, also, cholera spirillum loses virulence when grown in a current of sterile air.

One Set of Organisms can cause Lesions and Symptoms produced by a totally different Set of Organisms.—Diphtheria has been found to be caused by pneumococcus, scarlet fever by micrococcus catarrhalis, cerebrospinal fever by Klebs-Loeffler bacillus or bacillus typhosus. Symptoms

of rabies have been known to be caused by bacillus diphtheriæ, which, in turn, were found in the ear discharges of patients suffering from scarlet fever, while scarlet-fever germs may cause puerperal fever.[6]

The same Micro-Organism may give rise to totally different Lesions and Symptoms.—Diphtheria bacillus may give occasion to local diphtheria, acute blood poisoning, and paralysis. The streptococcus can produce at one time local suppuration, at another spreading erysipelas, and at another fatal septicæmia. The influenza organism in one form can give rise to epidemics of simple coryza, in another to rheumatic fever, in a third to cerebrospinal fever, and in a fourth to pneumonia. Micrococcus catarrhalis may cause acute pharyngitis, tonsillitis, common cold, sore throat, otitis media, meningitis, and epidemics resembling cerebrospinal fever usually associated with meningococcus. Virulent pneumococci lodging in the pharynx may produce pseudo-membranous angina, in the eye a severe conjunctivitis, and in the lungs pneumonia. A certain strain of streptococcus will produce arthritis, another strain endocarditis, and another gastric ulcer.[7] The pneumococcus may attack meninges, lungs, pericardium, peritoneum, or synovial membrane, producing different symptoms according to the part affected, while tubercle bacilli, as we know, are associated with meningitis, phthisis, joint disease, peritonitis, spinal caries, lupus, etc. The organism that causes paratyphoid may at times produce gastro-enteritis, which is clinically quite a different disease.[8]

Different Organisms may produce the same Symptoms.—Clinical symptoms of pneumonia[9] may be caused by pneumococcus, pneumobacillus, influenza bacillus and streptococcus aureus. Pulmonary affections are associated with many organisms, such as pneumococcus, streptococcus, micrococcus catarrhalis, influenza bacillus, etc. Tonsillitis may be caused by scarlet fever and diphtheria germs, while inflammation of the membranes of the brain can be produced by Frankel's pneumococcus, the streptococcus of erysipelas, the human and bovine tubercle bacilli, and bacilli coli communis.[10] Thus all the properties of micro-organisms

are subject to variation brought about by an alteration in their environment. The character of the culture media, exposure to a high or low temperature, the presence or absence of sunlight, of oxygen, of antiseptics—all play an important part in determining their shape, their type, virulence, pathogenicity, and every other character. We cannot rely upon any of the properties for the purpose of identification or classification. Many of Koch's postulates, which were once the causal test of specific organisms, have become untenable by the light of modern facts, as no single property can be considered specific or constant. If virulent organisms can become avirulent, and avirulent can become virulent, or if cocci can be transformed into bacilli, and *vice versa*, there can be no stability. If one kind of organism can produce symptoms belonging to quite another kind of organism, if different kinds of bacteria can produce similar symptoms, and the same bacteria can cause different disorders, or are found both in healthy and diseased persons, there can be specificity; and if the stability and specificity of bacteria become untenable, the very foundations of bacteriology are assailed.

Man himself provides the changing conditions of environment to the micro-organisms. The culture media and the temperature in which they are grown form the most important part of their environment. In ordinary conditions the intake of normal foodstuffs creates a normal metabolism in which bacteria take part. But abnormal or improper foods tend to create an abnormal process of digestion when the chemical and metabolic activities become deranged, toxins are formed which poison the body and the bacteria, and render them pathogenic. It has been proved that bacteria which are not present in the fæces of healthy animals appear after they have been given unwholesome and irritating food. Schmailowitsch[11] stated that the amount and nature of bacterial enzymes are modified by the amount and nature of the food. Development of toxicity has been shown to result upon alteration in metabolism brought about by a change in the kind of foodstuffs available.

So in the altered metabolism of the organism the metabolic products of bacteria themselves are deranged, which create toxins and poison man. Thus the administration of improper food, impaired metabolism, inflammatory condition and development of pathogenicity in bacteria follow one another in succession. The greater the abnormal changes in the body the greater is the virulence of bacteria. The very fact that they grow more rapidly in pathological exudations than in normal fluids shows that the altered metabolism offers a soil for their growth and virulence. We can roughly trace the life-cycle of a micro-organism, such as a pneumococcus, which at first does no harm in a healthy person; in the next stage it has been found virulent in the early stage of pneumonia, more virulent in the advanced stage of the disease, and then decreasing in virulence and becoming harmless when the patient reaches the convalescent state. So, also, in diseases like cholera, typhoid, and diphtheria (and, I would add, tuberculosis), the cycle from saprophytic to virulent and from virulent to saprophytic stage can be studied.

Just as domestic fowls when regularly fed and well cared for lay more eggs than wild fowls, so when micro-organisms, which are mostly vegetable cells, partake of rich or nitrogenous food, either in the artificial culture media of the laboratory or in the diet of man and animal, they acquire properties of increased growth and virulence, but when deprived of rich food, or kept in water, or exposed to air and sunlight, they die, and between these extremes—their increased virulence and their death—there are many grades and variations which make up the life-history of many bacteria. They have no innate virulent properties. It is environment that gives every character they possess, and man creates the environment in which they grow. No single property of bacteria can be regarded as specific. All the processes of adaptation and specialization of bacteria are due to the physical, chemical, and electric changes they meet in the human organism—*i.e.*, they adapt themselves to the surroundings in which they are placed. "I cannot find,"

says Professor Hueppe, "a fact which is in real harmony with Koch's conception of 'specific disease-germs.' Such constancy . . . made possible by the permanence of environment. Micro-organisms change with the changes in their surroundings" (*Principles of Bacteriology*, by Hueppe, p. 264). Permanency of type is only possible from permanence of environment, and permanence of environment can only be obtained where there is personality. The lower the organisms the more they are influenced by their surroundings. Micro-organisms being the lowest in the order of life can have little or no personality, and, therefore, exhibit properties and differences from adaptation and environment rather than from any specific powers, vicious or otherwise, inherent in themselves.

Tubercle Bacilli and Tuberculosis.—These considerations will help us when we come to study the life and character of the tubercle bacillus. As in the life-histories of spirilla which, growing in water, become transformed in course of time into cholera bacilli, of harmless coli bacilli at the one end which become at the other typhoid bacilli, of saprophytic pneumococcus found in the healthy mouth and throat becoming virulent causing pneumonia, so we think we can supply some of the links in the chain of evolution of tubercle organisms by tracing it from a saprophyte that is found in water, grass, and hay to the next stage in the cattle and other domestic animals and in their dung, then further on in cow's milk, butter, and cheese, and finally reaching human beings. The frequent appearance of pneumococci with tubercle bacilli in the sputum of consumptive patients, and their gradual displacement by tubercle bacilli in some cases, together with the transformation of cocci into tubercle bacilli by laboratory methods by Charlotte Young, and tubercle bacilli into coccoid forms by Maher, lends strong support to the belief we may trace the tubercle bacillus still further to coccal forms. Or we may agree with Dr. F. Vicentini,[12] of Italy, that *Leptothrix racemosa* is the parent of both the tubercle bacillus and the pneumococcus (and

several other bacteria, including the gonococcus). The tubercle bacillus belongs to a large group of acid-fast organisms which, besides the bovine and human type, include the hay bacillus, the butter bacillus, the smegma and the leprosy bacillus, Johne's bacillus, the diphtheroid group. Professor Hueppe thinks that tubercle bacilli are parasitic growth forms of a mould. Can the prevalence of tuberculosis in damp houses be accounted for by the formation of mould found in damp walls?

Stability of Type.—There are four types of tubercle bacilli—human, bovine, avian, and fish bacilli. While some regard the types as clearly distinct and stable, others hold that they merge into one another and find transitional forms. There are also others who believe that under favourable circumstances a given type may be converted into one of another type. Fibiger and Jensen[13] sum up extensive researches by saying: 'There are no characteristics of which one can say they are absolutely distinctive of the alleged types, and which may serve as trustworthy diagnostic criteria.' That this is more or less true we shall see as we proceed to study the various characters of the various tubercle organisms. As in other micro-organisms tubercle bacilli adapt themselves to conditions of artificial cultivation, and this adaptation would modify their morphological, cultural, and virulent characters.

Acid-fast, Morphological, and Cultural Characters.—There are degrees of acid-fastness in this group. Some species are only acid-fast under certain conditions of culture. Those isolated from cow's milk are acid-fast only when grown in the presence of fat. Ferran[14] noted that tubercle bacilli grown in broth after a lapse of a certain period of time begin gradually to lose one acid-fast characteristic after another until finally a non-acid type is produced. H. Dostal,[15] by maceration in normal salt solution and adding a glucoside, obtained pure cultures of tubercle bacilli which were neither acid-fast nor alcohol-fast, and differed from the original culture in appearance, growth, and virulence. Maffuci,[16] while artificially infecting the eggs of birds with tubercle

bacilli, found that they had lost their bacillary form and been converted into little coccoid bodies. Young, by a change of culture media and temperature, obtained two varieties of cocci from the bovine bacillus, a yeast and a torula from bovine and human tubercle bacilli. In old cultures tubercle bacilli appear as elongated and branched forms, and sometimes with clubbed ends. Mohler and Washburn[17] claim that various types of tubercle bacilli can be readily converted into one another by a prolonged residence in a suitable host. Nocard and Bang[18] allege that in a series of experiments they have succeeded in converting mammalian into avian tubercle bacilli. M'Fadyean[19] and others found bovine tubercle bacilli equally suitable with human to aid in the artificial culture of Johne's bacilli. Koch and Rabinowitsch do not see so sharp a distinction between the three types (human, bovine, and avian) of tubercle bacilli and are inclined to recognize transitional strains. They, with Romer, say that the larger the dose of avian tubercle bacilli injected subcutaneously in guinea-pigs the more the post-mortem appearance comes to resemble those caused by mammalian tubercle bacilli. Hueppe[20] found that the difference between the human and bovine varieties of tubercle bacilli is so small that when they have passed through guinea-pigs it is impossible to distinguish one from the other. Professor Hans Much[21] also argues for the identification of human and bovine types of bacilli, as the same agent differing only in its degree of adaptation to its surroundings.

Size and Growth.—Human bacilli may be as short as the bovine, and both the human and bovine differ very little in length if grown in pure culture on serum. Their growth depends upon the culture media and on the adaptation of various strains to conditions of artificial cultivation. On coagulated serum there is no obvious difference in the mode of growth of the human and bovine type. The difference in growth of these two types appears to depend upon the difference in their capacities for making use of glycerine. In time strains of bovine type may come to grow on broth as luxuriantly as the human type. The cultural characters of

avian tubercle bacillus may be practically indistinguishable from those of the human type. Those who, like Theobald Smith, laid great stress on the reaction curve will be disappointed, as Harden,[22] in his report, says he was unable to find a physiological difference between tubercle bacilli of different origins. So that the difference of type cannot with any real certainty be distinguished or judged by the morphological or cultural characters, or by the reaction curve.

Virulence.—A human type may produce a severe lesion in a calf, while the bovine type may be so slightly virulent as to throw doubt if it was bovine; while the bovine type found in man and the pig may not be so virulent as that found in the ox. When bovine bacilli are found in Indian cattle they are of lower virulence than those found in European cattle.[23] Maher's experiments in America[24] have shown that avian, bovine, and human tubercle bacilli can be so modified that they can grow in room temperature and lose their acid-fast character, their rod forms (and become coccoids), and their virulence. Again, Much's granules are considered to be tubercle bacilli of low virulence. Cobbett[25] says that experiments have shown that there is no difference in virulence between the human and bovine types found in monkeys. In monkeys there exist eugonic strains which are less virulent than the human type, and dysgonic strains which are less virulent than the bovine type of tubercle bacilli. When these types have lost their virulence they must become attenuated. Whether they became attenuated or belong to another type, whether the strains are previously of low virulence or lose their virulence during their residence in the animal, the fact to remember is that they do not exhibit the typical human or bovine character, and therefore lose their stability in type and virulence.

The only way to distinguish the types is to find out the difference in their virulence by animal experiments. But undue reliance cannot be placed on the pathogenic differences in producing disease in animals, as the calf may have extensive tuberculosis produced by human bacilli or scarcely any if the bovine dose is small. A large dose by intravenous

injection of human bacilli may prove fatal in a calf, while a small dose of the bovine kind may only cause local lesions. The difference in causing disease may also be due to difference in the resisting power of the animal and the virulence of the virus used.

The rabbit is most commonly used to differentiate between the human and the bovine type. But even here fallacy and uncertainty may creep in, as human bacilli may cause progressive tuberculosis in the rabbit if the dose is large, or if the injection be intravenous or intraperitoneal, or if the animal is highly susceptible, or scarcely any lesion if the bovine dose is small. Again, a small dose may cause a grave lesion in a rabbit if it is highly susceptible. The quantity of bacilli, the mode of administration, and the susceptibility of the experimented animal, would influence infection rather than the type used—human or bovine. The presence of spontaneous tuberculosis and the difference in the susceptibility of the animals employed are factors that dog the footsteps of all observers and tend to invalidate their result. So that we come to the same conclusion with regard to tubercle bacilli as with other micro-organisms—viz., that the difference of type cannot with any certainty be demonstrated by morphological, cultural, or virulent characters of tubercle bacilli. The existence of attenuated strains, or of high and low virulence by passage experiments, prove that they are capable of modification by environment, and that they have no inherent stability or specificity apart from their surroundings. The soil of the animal or man governs the whole situation as regards infection. Environment would intensify, lower, or neutralize the virulence of tubercle bacilli.

Clinically, the presence of tubercle bacillus is no indication of active tuberculosis any more than the presence of pneumococci, diphtheria, or influenza bacilli in a person is a proof that he is suffering from pneumonia, diphtheria, or influenza. On the other hand, the absence of tubercle bacilli does not prove that there is no tuberculosis. Tubercle bacilli may be found in the lymphatic glands, in the blood, in the bone-marrow, and without doing any harm, or it may be found

in the fæces without causing any tubercular lesion of the intestine. They were actually found in a case of typhoid.[26] Patients may have distinct clinical symptoms of pulmonary tuberculosis, and yet no tubercle bacilli may be found. One such case was reported by Sir St. Clair Thomson,[27] and many such cases are called 'abortive tuberculosis' by Bard and Fishberg,[28] and 'tuberculosoid' by Neisser and Bräuning.[29] It does not matter by what name they are called; the important thing is to recognize the existence of cases of tuberculosis without the presence of tubercle organisms, in the same way influenza cases are seen without Pfeiffer's bacillus. On the other hand, we have known patients who eat and sleep well and go to their daily work and enjoy good health and yet have tubercle bacilli in their sputum. Our experience is corroborated by Paterson,[30] who mentions he has known hundreds of such cases who have been discharged from sanatoria as fit for the hardest manual work, and who, nevertheless, expectorate tubercle bacilli in their sputum, while others with definite symptoms of tuberculosis are extremely ill and yet have no sputum, or, if they have any, repeated microscopic examination gave negative evidence.

As in the case of other micro-organisms, the tubercle bacillus may cause various lesions. In one it may produce phthisis, in another osteitis or arthritis, in the third lupus, and in the fourth meningitis, etc.; while other micro-organisms may produce symptoms of tuberculosis. Dr. Mitchell Clarke[31] gave several cases where Friedländer's bacillus was the chief morbific agent in causing pulmonary lesions simulating pulmonary tuberculosis. Sir James Goodhart[32] also described many patients in whom symptoms of pulmonary tuberculosis were associated with pneumococci. The writer[33] collected twenty-three cases of pulmonary disease received into the sanatorium, where nothing but some form of cocci were seen in the sputum. In one case pneumococci, which appeared for several months, were gradually replaced by tubercle bacilli. The writer has also seen cases which gave a history of influenza, but which in course of time developed symptoms of pulmonary tuber-

culosis. Bossert and Leichtentritt[34] describe several cases among children—which they call 'chronic influenza'—which, with old tuberculous lesions, developed symptoms of pulmonary tuberculosis (flattening of chest, infiltration of upper lobes, dulness with râles, etc.) and presented a positive Von Pirquet reaction with influenza bacilli in the sputum, but no tubercle bacilli. To diagnose such cases with every symptom of pulmonary tuberculosis (except tubercle bacilli), including a positive tuberculin reaction as 'chronic influenza,' is a confession that tuberculosis is not a specific disease, as other organisms can cause the same pulmonary symptoms, or that all the organisms that cause pulmonary disease, including tubercle bacilli, come from a common ancestry. At any rate, the presence of clinical symptoms is a much more true indication of tuberculosis than the presence or absence of tubercle bacilli.

Again, just as in malaria, symptoms may appear long before the parasite,[35] so symptoms of pulmonary tuberculosis may appear long before tubercle bacilli can be found. The argument that they are there in the body but cannot be demonstrated is simply begging the question, as, if even this be true in some cases, it cannot be true in hundreds of other cases. In affections such as rickets, strumous and scrofulous diatheses, and in those conditions such as post-nasal catarrh, deformity of thorax, icthyosis,[36] pleurisy, hæmoptysis, etc., we recognize a tuberculous soil without the presence of tubercle bacilli. So that the seed does not create the soil, if we may use the seed-and-soil illustration. On the other hand, the constitution must be undermined and the soil impaired before tubercle bacilli can make their appearance with any effect. What, then, is the connection between tubercle bacilli and tuberculosis? Mere association of a micro-organism with a disease does not prove that it is the cause of the disease, any more than the presence of eagles near a corpse shows that they are the cause of the dead body. There must be a favourable soil or environment before tubercle organisms can grow and produce disease symptoms. In other words, infection is conditional

to the soil. What the conditions and circumstances are that produce a tuberculous soil will be discussed in subsequent chapters.

REFERENCES.

[1] Chemical Pathology, by Gideon Wells.

[2] *Ibid.*, 1920, p. 114.

[3] *Journal of Physiology*, 1919.

[4] 'Some Common Modifications of Common Bacteria.' Read before the Pathological Section of the British Medical Association, July, 1914, by C. W. Young.

[5, 6] Transmutation of Bacteria, by Gurney-Dixon.

[7] Textbook of Infection Immunity, by John Kolmer.

[8] *Nature*, September 9, 1920, p. 42.

[9] *Brit. Med. Journal*, September 21, 1918, p. 323.

[10] Hueppe's Principles of Bacteriology, p. 174.

[11] Chemical Pathology, by Wells, 1920, p. 110.

[12] Bacteria of the Sputa and Cryptogamic Flora of the Mouth, by Dr. F. Vicentini.

[13] *Berlin. Med. Wochenschr.*, 1908, No. 45, p. 2031.

[14] *Journal of Organotherapy*, 1920, No. 2.

[15] *Amer. Rev. of Tuberculosis*, 1918-19, p. 55.

[16] The Causes of Tuberculosis, by Cobbett, p. 122.

[17] Evolution of Bacteria, by Nash.

[18] The Causes of Tuberculosis, pp. 304, 307.

[19] *Tubercle*, July, 1920, p. 477.

[20] Oeverland in *British Journal of Tuberculosis*, April, 1909.

[21] Pathological Biology in Tuberculosis, 1920, by Professor Hans Much.

[22] Harden's Report to the Royal Commission on Tuberculosis, 1913.

[23] A. L. Sheather, *British Journal of Tuberculosis*, October, 1920, p. 198.

[24] *Medical Record*, New York, December 11, 1920.

[25] The Causes of Tuberculosis, by Cobbett, p. 511.

[26] Seventh Report of Henry Phipps Institute, Pennsylvania, April, 1913.

[27] *Tubercle*, October, 1919.

[28] Pulmonary Tuberculosis, by Fishberg, p. 365.

[29] *Medical Annual*, 1914, p. 632.

[30] Shibboleths of Tuberculosis, by Paterson.

[31] *Bristol Medico-Chirurgical Journal*, March, 1914.

[32] Goodheart, *Lancet*, 1916, vol. i., p. 907.

[33] Muthu, *ibid.*, vol. i., p. 1014.

[34] *Deut. Med. Woch.*, February, 1913, p. 176.

[35] D. O'Connell in *Lancet*, February 28, 1920, p. 518, and the *Practioner*, January, 1921.

[36] Three Clinical Studies, by W. C. Rivers.

CHAPTER VI

CONCLUSION

'Happy the man whose steadfast eye surveys
The whole world's truth, its hidden works and ways;
Happy, who thus beneath his feet has thrown
All fears and fates, and Hell's insatiate moan. . . .
On kings and crowds his careless glance he flings.'

VIRGIL.

IN summing up the evidence brought forward so far to prove the infection theory of tuberculosis and in arriving at some definite conclusion, we must, like an impartial jury, bring to bear an open, unbiassed, and critical mind, a broad outlook of life that would survey every field and every branch of science likely to throw some light on the question, an intuitive understanding that, piercing below the surface of things, would seize hold of the essentials and discard the rest. The whole question of tuberculosis hangs upon its etiology. What are the various factors that make for the causation of tuberculosis, and what are their relative values? The attitude of those who believe in the germ theory of tuberculosis is this: The tubercle bacillus is the essential cause of tuberculosis in all its forms. Without the bacillary invasion there can be no systemic intoxication or clinical symptoms. It is the seed that creates the soil. At the very outset it must be conceded that undoubtedly there are some cases where tuberculosis is very likely conveyed from one person to another. But the question is, is it so in the majority of cases? Is the wide prevalence of tuberculosis in civilized countries due to infection from without? Let us briefly examine the evidence of the germ theory under the following divisions: Statistical, Bacterial, Pathological, and Clinical.

1. **Statistics.**—The statistical evidence is not reliable for many reasons. It can be so handled as to prove whichever side one's bias or prejudice is inclined. Weighty conclusions are often drawn from too scanty a material. How often medical men have made deductions from such small figures as 10, 12, or 50. The smaller the number of cases the greater is the percentage for or against the contention, and one or two cases in a small calculation inadvertently omitted or added from one side to the other will greatly increase or decrease the percentage and thus prejudice the whole issue involving thousands of human beings. Unless deductions are made from a large scale no reliance can be placed on statistical conclusions. Our methods of proving a case or estimating the value of a certain course of action are very often at fault. The profession is not skilled in collecting facts or sifting the value of evidence brought up. It blindly follows authority, or places undue credence on experimental results without taking care to verify or compare them with those of others. Medical men differ as to the interpretation of pathological and bacteriological findings, or as to what constitutes tuberculosis or infection, or early diagnosis, etc. This difference in the interpretation admits large loopholes for errors to creep in, thus vitiating the value of statistical evidence. What is wanted is some standard or codification which can be used as a basis for all experimental calculation and for checking tuberculosis data. If something like the statistical method of Pearson and his Biometric School were adopted with tuberculosis problems the statistical figures would speak with a greater accuracy and authority, as they have in estimating the value of tuberculin, etc. Even in the biometrical calculation the personal element is lost sight of. Cold figures cannot lend themselves to human interpretation. Man is a living being, and every life differs from another. As the leaves of a tree are not alike, so no two patients are similar in age, temperament, family history, character, surroundings, in the extent of disease or in their response to treatment, so that they cannot very well be grouped together to prove anything with certainty. All the study of statistics

can do is to enable us to form general conclusions when drawn from a very large number of cases.

2. **Bacteriological Evidence.**—At the very threshold of bacteriological and pathological evidence the student is confronted with a maze of confusion and contradiction both in theories regarding infection and the results of experiments. The very discoverer of the tubercle bacillus has made mistakes concerning many problems connected with tuberculosis. While he and his large number of followers explain infection as spreading from person to person through inhalation, Calmette and his school firmly believe in the intestinal origin of tuberculosis. And Romer[1] casts a doubt on both schools, and suggests that there must be some other mode of infection not yet known. So to this day we do not know the main channel of infection. Rosenberger[2] demonstrated tubercle bacilli in the blood of 100 per cent. of a series of forty-nine cases of tuberculosis, and later, of 300 cases by staining the organism in the centrifugalized sediment from citrated blood. But Ravenal and Smith,[3] Cotton, Schroder, Burville Holmes,[4] and others obtained uniformly negative results. On the other hand, acid-fast organisms have been found in connection with congenital bronchiectasis.[5] Kuvashige[6] found tubercle bacilli in the blood of apparently normal individuals. Brem[7] found them in distilled water. Bernard, Debré, and Baron[8] found acid-fast granules in pure antiformin. The controversy between Cornet who believed in dust, and Flugge who believed in droplet infection, is not yet settled. Kuss, Ghon, Albrecht,[9] Von Pirquet,[10] believe that the primary focus of tuberculosis in childhood is in the lungs, and spreads from lung to gland, while Shennan[11] and other English workers assert that it is rather from gland to lung. Koch, Cobbett, Griffith, and many other English and American workers, believe that bovine and human bacilli are two different and stable types of tubercle bacilli, but Much[12]—and many others are beginning to agree with him—argues for the identification of bovine and human types as being the same agent, differing only in its degree of adaptation to its surroundings. Wright and his followers[1] affirm that the

blood of those who become the subject of bacterial invasion is deficient in protective substances, while another school believes quite the opposite—that an infected person develops specific immune bodies. If, according to Wright, infected organisms are deficient in protective substances, how can these bodies be developed as a result of infection?—which is contradictory. The dose of a vaccine to be estimated by the opsonic index is based, like Metchnikoff's, on the phagocytic theory. But in many infections polyglandular leucocytes take little part against the invading organisms, so that the vaccine treatment and the theory based upon it would fall to the ground. The truth is that phagocytosis is not confined to leucocytes alone, but, as already seen, the spleen and liver cells, the endothelial and alveolar cells also take part. Again, phagocytosis is not directed against bacteria alone, but also against red cells, leucocytes, inert particles like coal dust—in fact, against anything and everything that acts like a foreign substance which nature wants to get rid of.

The same confusion is seen when the infection theory is applied to clinical medicine. If the bovine and human types are separate, and do not undergo modification as Cobbett says, how is it that in the majority of children under five years of age the human type is found?[13] If the human type be the cause of child tuberculosis, it cannot be through drinking cow's milk, as many pathologists allege. How does the human type get in in the child? Is it through the transformation of the bovine into human? But pathologists are not agreed that the types modify. Does the child pick up human bacilli by crawling on the floor or by coming into contact with adult tuberculosis? This may be possible here and there, but that every child in the civilized world should crawl and pick up bacilli on the floor, or be infected by an advanced case, is absurd on the very face of it. As Bracken[14] says, we know a large percentage of children grow up in homes where there are no open cases of tuberculosis. Therefore, surely the almost universal prevalence of tuberculosis among children cannot be accounted for by this crawling and contact theory.

Again, Riviere[15] and others have stated that the drinking of tuberculous milk by the children has an immunizing effect in the adult. If so, why take precautions against tuberculous milk either by boiling, sterilizing, or by legislating public health measures? One cannot have it both ways —denouncing tuberculous milk as a public danger and blessing it as an immunizer of children. Marfan,[16] as early as 1884, said that persons who had scrofula in childhood and completely recovered would never contract tuberculosis. As a matter of fact, tuberculous milk does not confer immunity. It is a common observation that children cured of scrofula furnish many cases of chronic pulmonary tuberculosis of adult life.

So we can go on multiplying instances how the infection theory has landed us in so many fallacies and contradictions. Bacteriology itself is in a state of flux. Its very foundations —the stability and specificity of micro-organisms—are being assailed. If the morphological, cultural, and virulent characters of an organism can be modified by an alteration in their environment, there can be no stability. If a microbe can produce two or three different diseased conditions, and three or four different kinds of organisms can provoke the same disease, there can be no specificity. The mutation of bacteria, unorthodox yesterday, is recognized as orthodox to-day by the light of modern thought.

Animal experiments have increased the confusion rather than clarified the position. You select a lower animal, a susceptible animal, and rear it in an artificial environment, and place it under conditions of fear and shock which favour the abolition of many of its physiological functions and the entrance of micro-organisms, you feed it with infected food, and, worse still, inoculate it with an enormous dose of virulent bacilli, which would never occur in a natural way, and then you cannot produce phthisis or anything similar to the spontaneous disease in man, and afterwards you go to apply such an unsatisfactory result obtained in such an unnatural manner to man who is infinitely separated from the lower order by virtue of his powers of mind, intelligence,

consciousness, and personality — no impartial jury would bring in a verdict that infection is proved from such a mass of irregular evidence. Morbid processes obtained by inoculation experiments on animals cannot be the same as those which occur spontaneously in man. Besides, artificially penetrating the skin, which is nature's coat-of-mail, and taking her fortifications by the flank, render animal inoculations very unnatural, and the results obtained by them can have no real value. Harmless enzymes found in the alimentary tract, while beneficial in the process of digestion and absorption, act like poison when injected into the body, causing fever, trembling, and even death (*Chemical Pathology*, Wells, p. 61). So it can be argued that the presence of tubercle bacilli in the organism may do no harm, but when inoculated in the body behave quite differently, and the lesions caused by such a procedure have no resemblance to what takes place if tubercle bacilli are introduced in the ordinary dose and in natural conditions. Clough,[17] an American worker, is obliged to admit that tuberculosis, as it commonly occurs in man, is not exactly analogous to that produced experimentally in animals. Such a candid confession throws a doubt on all the results obtained from experimented animals, rendering useless a mass of literature written on the subject.

Tubercle Bacilli and Tuberculosis.—The discovery of the tubercle bacillus does not prove that it is the cause of the disease any more than the presence of micro-organisms, such as the pneumococcus, the streptococcus and staphylococcus, the diphtheria bacillus and the influenza bacillus, proves that the person in whom they are found is suffering from their respective disease. It is generally recognized that healthy bodies may harbour saprophytes and even virulent germs without doing any harm to the organism. The presence of an acid-fast organism is no proof that it would cause tuberculosis. From what has already been shown, there is no doubt there is a close relationship between the four varieties of tubercle bacilli, and one can be transformed into another by a change of environment, such as culture media, temperature,

etc. We cannot modify to order in the limited time given to laboratory experiments. Because the pathologist may not witness the modification from the bovine to the human is no argument that this change does not take place in Nature. Most complicated chemical changes take place in the living cell with ease and rapidity which man finds difficult to imitate outside the body. Proteins are continually broken down to urea, carbonic acid and water, and yet to split proteins even as far as the amino-acid stage requires prolonged action of concentrated acids and alkalies, or superheated steam under great pressure.[18] Micro-organisms adapt themselves to given conditions of life. Environment modifies their culture, morphology, virulence, and every other character they possess. 'The specificity of the disease germ,' as Hueppe[19] remarks, 'is a phenomenon of adaptation.' If pathogenic bacteria are specific entities and are the only true cause of disease, as Koch and Pasteur affirm, at least four conditions will have to be fulfilled. (*a*) The disease-producing bacteria should cause no other effect than that of producing the disease. (*b*) Their ability to produce should be constant. (*c*) They should affect all animals in the same way. (*d*) They should produce only a single and sharply defined, typical and specific infectious disease. But we know that these conditions are not fulfilled in the case of many a specific organism. The *Spirochæta pallida* can be demonstrated by most observers in only 60 per cent. of chancres, and the gonococcus in not more than 15 per cent. of gonorrhea.[20] J. E. R. McDonagh[21] truly says that 'the greatest error of this era is the assumption that the *Spirochæta pallida* is the sole cause of syphilis.' Laveran's bodies are sometimes found swarming in the blood of persons, especially children, who may be in perfect health with a normal temperature; whilst in others suffering from a clinically typical malarial fever not even one parasite can be found.[22] Klein, in 1893, said he found *Bacillus Pfeiffer* in every case of influenza (Local Government Report, 7051, 1893), and he was supported by Kitsato; but now modern workers have found the bacillus in healthy individuals, in

diphtheria, scarlet fever, measles, broncho-pneumonia, tuberculosis, and in bronchiectasis; and while in typical influenza cases it may be absent, other organisms, such as pneumococcus, streptococcus, etc., may be present. So in tuberculosis the presence or absence of tubercle bacilli without clinical symptoms cannot be taken as an indication that the patient is or is not suffering from active tuberculosis. So that we cannot, as the *Lancet* says (March 20, 1909), rely upon Koch's postulates as a decisive test of a causal organism. In the whole group of acid-fast bacteria, ranging from the so-called pseudo-tubercle bacillus to the human type, we find that environment modifies all their characters, and we cannot distinguish the different types from their morphological and cultural characters, and even their virulence can be modified by environment. Such conditions as fresh air, sunlight, etc., can neutralize their virulence so that they become saprophytes, and, on the other hand, vicious hygienic conditions may intensify their virulence. The drinking of tuberculous milk need not give tuberculosis to children, either because the tubercle bacilli found in it are saprophytes or the children can resist their virulence. So in the case of hundreds of patients discharged from various sanatoria, who are well and strong enough to carry on their daily work, and who expectorate tubercle bacilli in their sputum, the tubercle germs have been rendered harmless by their sanatorium life, or any virulence found among them has been nullified by their powers of resistance. Thus man, and not the microbes, speaks the last word in the causation of tuberculosis.

Pathology.—Mere enlargement of a lymphatic gland is no proof that it is tuberculous. Histologically a gland may be perfectly healthy and yet contain tubercle bacilli; on the other hand, a tuberculous gland may not contain any bacilli whatever. Tubercles may be produced by a variety of conditions apart from tubercle bacilli. Lubarsch[23] has shown that tubercles were produced by the injection of Timothy grass bacilli, which could not be distinguished from those formed by Koch's bacilli. Experimental tubercles are not

the same as spontaneous tubercles. The physiological explanation of a tubercle, as described before, is more in keeping with observed facts, and better interprets the presence of its various constituents than the theory of its bacterial origin. Even post-mortem examination gives one neither definite nor conclusive evidence of tuberculous disease. What one observer considers a lesion as tuberculous in nature another may deny, and personal judgment goes a long way in deciding the character and extent of the disease. In hundreds of cases where people have died from accident or some other disease post-mortem examination has revealed signs of extensive disease of the lungs, and yet they have lived many years unconscious that anything was wrong with them. Besides, children riddled with tuberculous glands get well and enjoy good health. These facts go to show that tuberculosis does not behave like an infectious disease; indeed, they make us doubt whether in its very incipient stage it can be called a disease in the ordinary sense of the term. The very fact that the injection of tuberculous tissue containing tubercle bacilli produces a more severe lesion than the same number of bacilli injected alone shows that tubercle bacilli take their virulence from the soil and are poisoned themselves through it.

Specific Infection.—Prenatal infection in human beings, if it occurs at all, is so rare that it can be considered as a negligible factor. There is no evidence of conjugal infection in the majority of married cases, and there is no more proof in contact infection than there is in the case of married couples. The occurrence of multiple cases of tuberculosis in the same family or in the same house is more likely due to the inmates living under the same conditions of environment, such as poverty, overcrowding, and other unhygienic surroundings. It may be conceded that here and there an advanced case of tuberculosis may cause infection among those living in the same room under bad economic and insanitary conditions, but there is no proof that such extreme conditions prevail in the majority of cases of tuberculosis. There is a great consensus of opinion that consumptive hospitals and sanatoria are free from tuberculous infection.

The theory of aerial infection is more and more denied by expert observers. As for milk, those who drink little or no milk have more tuberculosis than those who drink more. In countries like India, China, Japan, Siam, etc., where children are breast-fed and where native cattle are more or less free from tuberculosis, the disease among adults and children is as prevalent as in European countries. Both the children and cattle fed on tuberculous milk have often been found free from tuberculous disease.

Clinical Experience.—Study the infection theory in connection with any phase of clinical tuberculosis:

Is it the patient's clinical history? Hundreds of patients give no history of exposure to infection. On the other hand, the writer has seen spontaneous cases of consumption in a remote house far removed from human habitation and fanned by the four winds of heaven.

Is it the diagnosis? Again, in hundreds of cases there is either no sputum, or tubercle bacilli cannot be demonstrated even after the most careful and repeated examination of the sputum. Such cases may be called 'influenzal pneumonia,' 'abortive tuberculosis,' 'tuberculosoid,' or 'pneumococcal bronchitis.' It does not matter by what names they are called, the fact will have to be recognized that typical clinical symptoms of pulmonary tuberculosis can be accompanied by an absence of tubercle bacilli.

Is it prognosis? Patients with grave and prolonged symptoms of pulmonary tuberculosis have yielded no tubercle bacilli, while those who get well in many sanatoria and are discharged as fit for work have continued to bring tubercle bacilli in their sputum. As one such asked the writer: 'I eat well, I sleep well, I feel well, what is this t.b. you are searching for?'

Is it treatment? Tuberculin treatment as based on the germ theory has failed to arrest the disease in so many instances that it is being gradually abandoned by many hospitals and sanatoria at present. The writer gave up using it many years ago when it was so popular, as he found it not only worthless, but actually harmful in some cases.

Therefore the truth must be borne in mind that cases of phthisis can occur without the presence of tubercle bacilli. Those who believe in contagion affectionately cling to such words as 'pseudo-tuberculosis,' 'infection,' 'immunity,' 'mass infection,' 'carriers,' as if they explained everything to justify their belief in the germ theory of tuberculosis.

Pseudo-tubercle.—To make a difference between pseudo-tubercle and the tubercle germ is quite arbitrary. The difference in their histology is a difference in their adaptation to environment. Biology emphasizes that a saprophyte can take on pathogenic properties through a change in its nutrition and cultivation.

Infection.—The word 'infection' is indiscriminately used for anything and everything connected with tuberculosis, even when there is not the slightest sign or trace of infection. To get over the difficulty a distinction is made between infection and disease. Can pathology recognize that infection can occur without disease? For in infectious diseases like measles, smallpox, scarlet fever, etc., disease symptoms manifest themselves after infection. If infection does not provoke tuberculosis, why trouble about infection at all? We do not take notice of streptococci, diphtheria, and other germs found in healthy people. If the presence of tubercle bacilli is no indication of disease, there must be other factors which make for tuberculosis.

Immunity.—Though so much has been written about immunity, we honestly know neither its mechanism nor how and where it is produced. The germ theorists hold that the decline of tuberculosis in civilized countries is due to the immunity obtained by the gradual infection of the people. If such a natural immunity be the explanation of the fall in tuberculosis mortality, why should it (the fall) be so unequal in civilized countries that are close together and where tuberculosis is equally widespread? Why should England show a death-rate of 116 per 100,000 in 1915, and France 179: Scotland 111, while its neighbour Ireland shows a death-rate of 172? As Sir Robert Philip[24] says, 'the

fascinating theory of communal immunity on natural lines fails badly when tested by hard facts.' If immunity is due to the production of specific antibodies such as have been found in the blood in tuberculosis, how is it that this allergic condition cannot be conveyed from one animal to another by the transference of blood? There is no proof at present that cells carry the antibodies instead of the blood.[25] On the other hand, Nature brings about allergic and immunized reactions by means of inflammation, which is a natural and physiological process. So that while the bacteriologist connects immunity with micro-organisms, the biochemist and the biologist suggest that immunity reactions are chemical and physiological rather than bacterial.

Mass infection may be artificially produced in animals by injecting large quantities of virulent bacilli, but this is a different thing from showing that it occurs in human beings under natural conditions. Even in animals the intra-peritoneal and intravenous injections prove fatal from general toxæmia rather than from bacterial infection. We do not know what mass infection means. If it means infection by a large quantity of bacilli, we have no proof that it takes place in ordinary life, or that it has been found to prove fatal under natural conditions. If it does take place, contact with cases of advanced tuberculosis, or drinking quantities of tuberculous milk, would furnish many instances of mass infection. We have already drawn attention to the fact that Drs. Haldane and Barwise[26] have observed that, while phthisical tin-miners and grit-stone workers do not go to a hospital, but stay at home and expectorate sputum loaded with tubercle bacilli, their wives and children never seem to be affected with the disease. We have also quoted instances from New York and Germany of children drinking tuberculous milk for a considerable time without contracting the disease, showing that even a close contact with advanced tuberculosis or drinking tuberculous milk need not necessarily produce tuberculosis.

Carrier Theory.—Though a great commotion and alarm were created about typhoid carriers, Dr. Hamer,[27] in his

latest Council Report, gently throws overboard both 'Typhoid Mary' and the 'Folkestone carrier,' by saying that 'in neither of these classical instances was the case proven.' He also mentions that, in spite of typhoid prevailing in considerable excess in 1898, 1899, and 1890, and the consequent appearance of many hundreds of carriers of typhoid bacilli newly on the scene, the succeeding years, instead of showing a rise, had shown a steady decline, and adds that facts of this nature are 'wholly irreconcilable with the bacillus carrier thesis.' Cannot the same be said of tuberculosis also? If, according to Osler,[28] in Ribbert's laboratory tuberculous lesions are found in practically 100 per cent. of the bodies of adults, every civilized human being must be infected with the disease, and therefore, if the disease becomes active, every one of us will become a carrier and liable to infect others!

The truth is that every theory and treatment of tuberculosis based on infection has led us into fallacy, confusion, and contradiction. The medical mind has been trained for a generation to think and act bacteriologically. The luxurious development of bacteriology has side-tracked medical research, narrowed its vision, exaggerated the part played by the micro-organisms, and distorted the perspective of healthy and diseased conditions. In fact, our knowledge of tuberculosis is still in the making. We cannot definitely say how epidemics originate, how symptoms of disease are produced, how immunity is acquired. Resistance is still a mystery which Nature holds in her hand. It cannot be measured by any mechanical means or laboratory method. Experiments *in vitro* cannot be taken as examples of what takes place *in vivo*. Substances that are highly bactericidal *in vitro* may prove to possess a high degree of toxicity *in vivo* for the living animal. We have no proof that bacteria act in the living body in the same way as they do in the test tube. We do not know anything definite regarding the nature or the structure of opsonins, antibodies, amboceptors, complements, etc., or the mechanism of their action, or the conditions of their production. The tendency of the present day is to run

after and accept every new and strange doctrine concerning tuberculosis without giving due weight or consideration. It may be the opsonin theory of Wright, the phagocytic theory of Metchnikoff, the side chain theory of Ehrlich—each school has its own cult and followers, and interprets the phenomena of disease and immunity in its own way, and coins its own words to support its theory, and yet how much of the past researches have become out of date. In the diagnosis of tuberculosis, the cutaneous tuberculin test, the precipitin reaction, the albumin reaction, the leucocyte count, the opsonic index, the complement fixation, the presence of tubercle bacilli in the blood and fæces—one by one they have been brought forward as infallible tests, but they have failed to give a positive evidence of pulmonary tuberculosis. Experts themselves are not agreed in their results and conclusions, and are often found in opposite camps contradicting one another. What was discovered yesterday is doubted to-day and discarded to-morrow. The literature of tuberculosis is strewn with the wrecks of theories once popular, but now almost forgotten and cast away.

But science is ever progressive, the evening finding her nearer truth than the morning, though the goal is ever elusive and as far away as the distant hills. The inner shrine of truth is more easily reached through the intuitions of the mind and spirit than through physical observation or mathematical deduction. The world is built on a larger scale than for microbes. The pathologist is inclined to see infection in every germ and disease in every abnormality, because he surveys life's processes from the artificial surroundings of a laboratory, and judges a living man from the findings of a microscope. Hence his judgment leads to fallacy, his conclusions lend themselves to contradiction. If animal experiments cannot be relied upon as to what takes place in man, if stability and specificity of micro-organisms have proved untenable, if Koch's postulates are no longer a causal test of a specific organism, if immunity is a biochemical rather than a bacterial problem, if the presence or absence of tubercle bacilli gives one no idea as to the presence

of active tuberculosis in the body, we have a right to question the evidence of infection. The theory that 'stamp out bacteria, and you will stamp out disease' cannot hold good at the present day. Not till England comes to see, as America[29] has already done, that the tubercle bacillus is no longer tuberculosis can any progress be made in solving the problems of tuberculosis. Bacteriology has done its work in calling attention to the invisible organisms that play their part in health and disease. The germ theory of tuberculosis has served its purpose as a working hypothesis, a stepping-stone, the vantage ground from which we now behold broader horizons, wider fields where deeper factors than micro-organisms are seen to be working. There are already signs that the place so long usurped by bacteriology in the medical world is being challenged by such sciences as biochemistry, biology, psychology, and sociology, which are knocking at the door of medical research to place their contribution for a wider conception of life and disease processes. They are showing that man is more than microbes, that the proper study of man is man himself, and that his daily habits and living, his social and economic environment, have much to do in shaping his life, health, and disease condition. What these environmental factors are we shall proceed to study in the following chapters.

REFERENCES.

[1] Romer, Pulmonary Tuberculosis, by Fishberg, p. 51.

[2] Mildred C. Clough in *Amer. Rev. of Tuberculosis*, December, 1917, p. 607.

[3] *Journal of Amer. Med. Assoc.*, December 4, 1909.

[4] *Amer. Journal of Med. Sci.*, January, 1910.

[5] *Amer. Rev. of Tuberculosis*, 1919-20, vol. iii., p. 62.

[6], [8] Mildred C. Clough in *Amer. Rev. of Tuberculosis*, December, 1917.

[7] *Journal of Amer. Med. Assoc.*, September 18, 1909.

[9] *Medical Annual*, 1916, p. 611.

[10] *Edinburgh Med. Journal*, 1914, vol. ii., p. 220.

[11] 'Morbid Anatomy of Tuberculosis in Man,' by Shennan, *Lancet*, March 7, 1914, p. 675.

[12] Pathological Biology in Tuberculosis, by Professor Hans Much.

[13] 'Bovine and Human Types of Tubercle Bacilli,' by Park and Krumwiede, *Journal of Med. Research*, September, 1912, vol. xxvii., No. 1, p. 111.

[14] Bracken, *Amer. Rev. of Tuberculosis*, 1918-19, vol. ii., p. 74.

[15] *British Journal of Tuberculosis*, 1914, vol. viii., p. 83.

[16] Marfan, *ibid.*, p. 69.

[17] Clough, *Amer. Rev. of Tuberculosis*, December, 1917, p. 618.

[18] Chemical Pathology, by Wells, p. 53.

[19] Principles of Bacteriology, by Hueppe.

[20] The *Practitioner*, January, 1920, p. 18.

[21] *Ibid.*, January, 1921, p. 26.

[22] Matthew D. O'Connell, the *Practitioner*, January, 1921, p. 72.

[23] Contributions to the Physiological Theory of Tuberculosis, by Creighton, p. 125.

[24] 'Present-day Outlook on Tuberculosis,' being the inaugural address delivered in the University of Edinburgh, April 16, 1918, by Sir Robert Philip.

[25] *Amer. Rev. of Tuberculosis*, September, 1917, p. 442.

[26] Pulmonary Tuberculosis, by Fishberg.

[27] Report of the County Medical Officer of Health for 1919. London.

[28] The Principles and Practice of Medicine, by Sir William Osler. London, 1904.

[29] Krause in *Amer. Rev. of Tuberculosis*, August, 1920.

CHAPTER VII

THE HISTORICAL AND ECONOMIC SURVEY OF TUBERCULOSIS

HAVING briefly considered tuberculosis from the point of view of infection, we now proceed in the following chapters to enquire into man's environmental conditions to see if they offer a better explanation of the etiology of the disease.

1. **A glance at the history of medicine** in bygone centuries brings out the fact that tuberculosis is a disease of every ancient as well as modern civilization. The evidence of the disease among ancient nations is furnished by the study of human remains unearthed by archæologists, of caries found in skulls, vertebral columns and other bones among Egyptian mummies and elsewhere, and of the records left in India, Greece, Rome, Nubia, Arabia, and later in medieval times in Italy, France, Spain, and Portugal. The Hindu physicians, Charaka and Susruta, who lived a long time before the Buddhist period (600 B.C.), have left a fuller account of the disease than many other ancient writers. Greeks under Hippocrates, and Roman and Arabian physicians, have followed, and in some ways amplified the writings of the ancient Indians. Charaka devotes a whole chapter on consumption (Sosha), and gives four varieties of phthisis. Susruta, who was more a surgeon than a physician, also gives an account of the disease in his voluminous book on medicine. The principles of their treatment seem very much like those carried out in an open-air sanatorium at the present day. They prescribed a meat and milk diet, the flesh of goats, deer, pigeons, etc., curries cooked in ghee (clarified butter), animal broths with barley, rice, etc. They gave their patients goat's milk and butter made from it with sugar, or fresh butter with sugar or honey, ass's milk, garlic, pepper, etc. They recommended them to live among the goats, evidently with a view to inhaling the ammoniacal

emanation from the urine of the animals. They attributed the disease to grief, violent exercise, to old age, diminished bodily and mental strength, and excesses of all kinds. Their insistence on feeding the patients with nourishing food, especially with milk, butter, and animal food suggests that they had an idea that tuberculosis was due to lack of nutrition.

2. **The history of tuberculosis and its rate of mortality in England and Wales** during the last sixty or seventy years, when studied in the light of economic facts, brings out many interesting points: (*a*) First we notice that there is a general decline in the death-rate from tuberculosis in almost all parts of the civilized world, beginning in the forties with Great Britain and extending all over Europe for subsequent decades. (*b*) The decline in the tuberculosis mortality began to take place long before the tubercle bacillus was discovered or any preventive measures were taken against the spread of the disease. In fact, the writer[1] has already pointed out that the fall in the rate of mortality was greater before than after any active measures were introduced. Taking the mortality rate of phthisis in England and Wales for forty years from 1875 to 1915, we find that during the last twenty years—1895 to 1915—in spite of extensive propaganda and great efforts to destroy infection which were made, the death-rate has not only not fallen in the same proportion as in the previous twenty years, but has steadily increased (Fig. 10). (*c*) We also find that the general death-rate has fallen to a greater extent than the phthisis rate. Karl Pearson,[2] analyzing the death-rate of general diseases and phthisis in England and Wales, divides the seventy-five years (1835 to 1910) when the records were kept into three periods, and shows that—

	General Death-Rate.	Phthisis Rate.
In the first period (1835-1860).	Fell very slowly.	The fall is pronounced.
In the second period (1860-1885).	There is more pronounced fall.	The fall not so pronounced.
In the third period (1885-1910).	There is more pronounced fall.	There is a check in the decline.

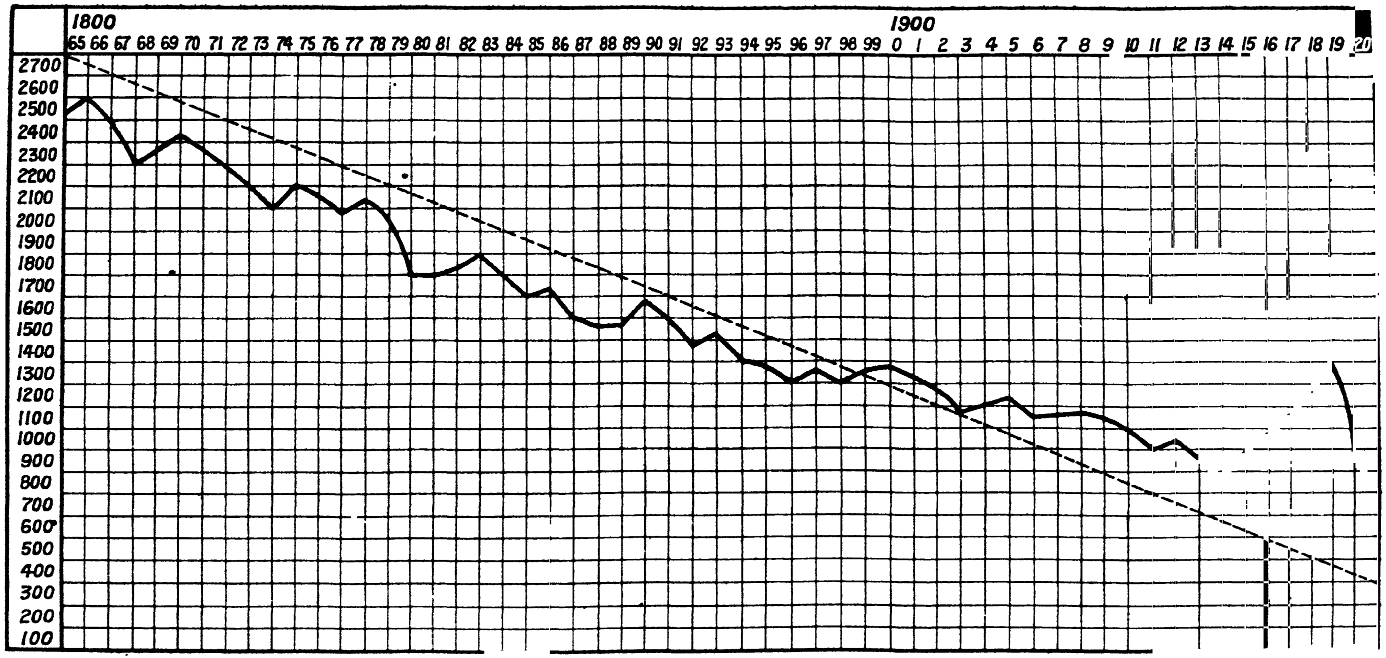

FIG. 10.—DIAGRAM ILLUSTRATING THE MORTALITY OF PULMONARY TUBERCULOSIS IN ENGLAND AND WALES SINCE 1865.

The dotted line shows the steady decline up to the year 1896. In the following years the rate of decline was insignificant, and fluctuated above the dotted line till 1913, when the rate of mortality quickly rose till 1918.

Had the death rate between 1895-1920 made the corresponding decrease it did in the previous 25 years (1870-1895), it would stand at 600 per million at 1915 and 300 to 400 per million at 1920.

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which means that while the death-rate from general diseases has steadily fallen during the last twenty-five more than in the previous twenty-five years, the death-rate of phthisis declined less and increased relatively during the last twenty-five years.

That this is also true in regard to America is borne out from its statistical records. Dr. Mays,[3] taking the death-rate of tuberculosis in New York city from 1887 to 1911, divides the period into two equal parts of twelve years. The first half of the period—1887 to 1899—covers about five years, in which preventive measures against tuberculosis were not chiefly in evidence; but in the second half—1899 to 1911—the crusade against consumption was in full force. During the whole period the death-rate fell 43·61 per cent., of which 25·51 per cent. belonged to the first and 18·10 per cent. to the second half of the whole period, showing that the decrease was 7·41 per cent. less in the second half than in the first half of the whole period. According to Dr. Hoffmann's New York Consumption Statistics[3] from 1882 to 1911, the total fall of death-rate for the whole period was 40·03 per cent., of which 27·44 per cent. goes to the first and 12·62 per cent. to the second half of the whole period—which means that the death-rate of consumption decreased more in the first half of the period by 14·82 per cent., when no efforts were made to combat tuberculosis, than in the second half of the period when such efforts were carried out.

Dr. Menzies,[4] Medical Officer of Health for the County of London, points out in his report for 1919, as the writer had done in 1912, the curious irony that while the death-rate declined uniformly up to the time of discovery of the tubercle bacillus, it has since maintained a steady rate and recently even risen during a period in which there has been a wide acceptance and vigorous application of Koch's views. If not due to anti-tuberculous measures, what is the explanation of this greater fall of mortality in the early forties both in England and America? Is it due to the tubercle bacillus having lost much of its former virulence? Dr. Menzies rightly contends that there is no positive evidence that the

tubercle bacillus has lost any of its virulence, and the fact that the disease has behaved in a totally different way in Ireland is very much against the theory of diminished virulence of the bacillus. Is it because the intrinsic capacity for resistance of the race is increasing? We have already seen that the difference in the behaviour of the death-rate in neighbouring countries like France and England, or Scotland and Ireland, precludes the possibility of communal immunity accounting for the decline. Is there any evidence that institutional segregation has anything to do with the decline, as Sir Arthur Newsholme has alleged? A stay of three months or so in a sanatorium out of a total infective period of many months or years of a few hundreds out of thousands of consumptives cannot possibly have any influence in the decline of the mortality rate. Besides, Dr. Bulstrode pointed out in the Local Government Report, 1908, that if segregation was to be credited with bringing about a decline in the death-rate, that decline would be augmented during the next ten years, 1908 to 1918, whereas the reverse has proved to be the case. The fact that the rate of decline instead of increasing has slowed down and is rising has upset all the theories of those who hold that the decrease in the mortality rate is due to the decrease of virulence, to racial immunity, and to segregation.

Menzies, after remarking that not one of the above-mentioned factors affords an entirely satisfactory explanation, concludes by saying, as other authorities have done, that the general improvement in the conditions of life of the working-classes has been a powerful factor in influencing the decline in the death-rate of tuberculosis. Such a conclusion is supported by a study of the economic history of England during the last sixty years.

3. **Tuberculosis and the Economic History.**—The decline in the death-rate of tuberculosis in England in the early forties may be due to many factors. During the thirties and forties the working of coal and iron mines which gave England the command of European and American markets, the introduction of steam and the invention of cotton machinery which

expanded her industry and her manufacture, the flow of treasure from India and gold from California which increased her bullion—all these contributed to her wealth and prosperity. The Bank Act of 1840 expanded her currency. The repeal of the Corn Laws in 1847, and the subsequent admission of free imports into the country, cheapened bread and other necessaries of life, and ameliorated the misery and poverty of the people. In 1845 the first Public Health Act was passed, and in 1847 the appointment of medical officers of health in several towns was followed by many sanitary reforms, such as improved drainage and water supply, the erection of healthy working-class dwellings, etc. Thus the inauguration of efficient, economic, and sanitary measures, ensuring a higher standard of living among the workers than in other European countries, would account for the fast decline of tuberculosis mortality during the forties and fifties.

The Crimean war in 1854 and the Indian mutiny in 1857 evidently brought distress and anxiety to the English people, as seen in the rise of the mortality rate. Another rise in 1866 marks the era of cotton famine in the years between 1863 and 1866. Every period of war and famine, and every crisis in the industrial world, has a devastating effect on the people, especially the working-classes when the increased price of food is followed by increased poverty and overcrowding of the workhouses with the unemployed, increase of crime, and in the rate of mortality including tuberculosis.

The seventies came in with improvement in trade and industry, increased prosperity, and the steady decline in the death-rate of tuberculosis till 1878, when it began to rise (see Fig. 10). There was another fall in the eighties, which corresponds with a period of unbroken peace, when railways were built on a large scale, and the production of foodstuffs, of minerals, and of manufactured goods increased by leaps and bounds. So that between 1843 and 1884 Dr. Baskett[5] calculates that the average income of a working-man's family rose in money value from £40 to £85 or £90 a year, and that all the time the money was actually purchasing more food and commodities.

In 1889 there commenced another great disturbance in the economic field, followed by a rise in the mortality curve, which very nearly touched the dotted line in 1890. Revolution broke out in Brazil in 1889, in Argentine in 1890, in Chile in 1891; banking failure in Australia from 1891-1893, great currency crisis in America from 1893-1896—all of which had a depressing effect in this country. Ever since 1894 the prices of various commodities have been going up. In 1894 English wheat touched 22s. 10d. per quarter, and rose to 28s. 4d. in 1904 and 34s. 11d. in 1914.* The steady rise in the cost of living in the nineties, as seen below, precipitated a great strike in 1911 among the miners, seamen, dockers, and railway men.

	Average Wage.	Bread.	Bacon.	Sugar.
1900	100·0	100·0	100·0	100·0
1910	99·70	114·8	138·9	124·3

In 1898 the long period of peace was broken by the Spanish-American war, which was followed by the South African war in 1899 to 1902 and the Russo-Japanese war in 1904 to 1905. These series of wars from 1898 to 1905 caused an unproductive expenditure of £900,000,000, and resulted in diminished production and increased demand, and the consequent marked advance in prices and commodities and increase in the cost of living, so that in 1898 the mortality rate of tuberculosis so increased that the curve crossed the dotted line for the first time for fifty years and has not since fallen below the line.

Though the wages were rising, the prices of food and other commodities were rising still more, so that the real wages—*i.e.*, the actual wealth passing into the hands of the workers—have been falling since 1896, and right up to the great European war in 1914, and much more so ever since.

Side by side with the increased cost of living, as pointed

* The prices since 1914 are: 1915, 52s. 10d.; 1916, 58s. 5d.; 1917, 75s. 9d.; 1918, 71s. 11d.; 1919, 72s. 11d.; 1920, 90s. 8d., falling steadily to 46s., 50s., in October, 1921.

out by Dr. Baskett,[5] there has been an enormous increase in the rates caused by the ever-growing expenditure in municipal and national service. In 1905 the municipal debts came to rival the national debt. According to Mr. Tom Myers, M.P.,[6] the outstanding debt of the local authorities in 1920 was £558,000,000, and the amount raised in local rates for the current year 1921 will not be less than £100,000,000. The increase of national and municipal taxes, which also means increases of food prices, must fall heavily upon the poor and middle classes. For a rise in rates and taxes, and the prices of life's necessaries, bring in their train more poverty and under-feeding, less resistance to fight disease, and an increase in the death-rate of tuberculosis, as is demonstrated by the mortality curve which is seen going above the dotted line since 1898, and further and further up since in spite of the active crusade against tuberculous infection. Thus the mortality chart, when studied in the light of the history of the living conditions of a people, becomes alive with momentous facts, showing a close bearing between the social and economic conditions and the mortality rate of tuberculosis—rising during a social, industrial, or economic crisis, and falling in times of peace and prosperity. In this connection, the close relation between tuberculosis and leprosy makes us draw attention to the observations of Creighton, Hutchinson, and Newman[7] that the decline and final extinction of leprosy in Great Britain is due to an extensive social improvement in the life of her people and to a complete change from the former poor and insufficient diet.

4. **Clinical experience** among many observers on tuberculosis also bears out the close connection between poverty and tuberculosis. The writer, while working for some years in a working-class community, noticed over and over again that as long as there was employment, good wages, good food and freedom from anxiety, the working people fared well and kept free from tuberculosis; but unemployment, poor wages, scarcity of food, and anxiety in the household, brought chronic underfeeding, sickness, distress, and a

recrudescence of tuberculosis which further increased their poverty.

5. **The study of history** will furnish a still more general resemblance between poverty and sickness. In all great wars, famines, and great sieges, from the siege of Paris to the siege of Kut-el-Amara, it is known that underfeeding and starvation lowered resistance, and was followed by a widespread visitation of typhus, typhoid, plague and pestilence, scurvy, dysentery, etc. The extreme dearness of living during the wars with Napoleon is a matter of common knowledge. In the same way, the Crimean war, the Indian mutiny, the Italian war, the American Civil war, and many other subsequent wars have caused an enormous unproductive expenditure and increase in prices of food commodities, and unemployment and poverty. During the great European war, 1914 to 1918 and after, it is impossible to forget the terrible tragedy that overtook the countries of mid-Europe, where thousands and thousands of children and adults became victims to chronic starvation and malnutrition, rickets and tuberculosis. The widespread calamity and distress to her children has brought home to Germany—the birthplace of the discovery of tubercle bacillus, and in fact of the germ theory of disease—that tuberculosis is more an economic than infectious disease. Professor Kayserling,[8] one of the foremost German authorities on tuberculosis, laments that all the progress of years has been swept away, and Germany is back at the point she had reached in the eighties. Other German physicians are now beginning to say that tuberculosis should be regarded primarily not as an infectious disease, but as a disease of nutrition to be controlled much more by feeding than by preventing infection, and that if only food could be procured the cases of bone and gland tuberculosis in children could be made to improve amazingly. From Austria come the reports that as the result of continuous underfeeding and hunger, the wards of the Vienna hospitals are filled to overflowing with dropsy, scurvy, rickets, and Barlow's disease[9] (a disease due to malnutrition). So that the study of all the facts which

the economic survey of these countries has furnished strongly suggests that in civilized countries the social, economic, and industrial factors more largely influence the incidence and mortality of tuberculosis than any tuberculous infection. There are also other factors which we shall examine as we proceed.

REFERENCES.

[1] The *Practitioner*, February, 1918, p. 109.

[2] Karl Pearson, The Fight against Tuberculosis and the Death-Rate from Phthisis.

[3] 'Fancies, Facts, and Consumption,' by Thomas J. Mays, *New York Med. Journal*, November 14, 1914.

[4] Report of the London County Council Medical Officer of Health and School Medical Officer for 1919.

[5] 'Public Health *versus* the State,' by Baskett, *Brit. Med. Journal*, January 10, 1920.

[6] 'Municipal Finance,' by Tom Myers, M.P., *Labour Leader*, October 7, 1920.

[7] Evolution and Disease, by Nash.

[8] Kayserling, *Medical Officer*, August 30, 1919, and *Tubercle*, September, 1920, p. 583.

[9] *Brit. Med. Journal*, September 13, 1919.

CHAPTER VIII

THE BIOCHEMICAL ASPECT OF TUBERCULOSIS

'If we examine into the recent advances of medicine we will find that a large percentage of these have been made possible by the aid of a knowledge of physiological chemistry and nutrition. . . . The future of medicine rests with clinical chemistry and nutrition.'—SIR WILLIAM OSLER : *System of Medicine.*

EVER since the discovery of the tubercle bacillus, the development of pathology and bacteriology, following the lead given by the German school of thought, has made rapid strides, and has guided the workers to investigate all diseased conditions in relation to bacterial infection. While the principles of the germ theory were being strenuously pushed forward during the past generation, the science of biochemistry has slowly advanced, and is engaged in lifting up a part of the veil and bidding us gaze at Nature's manifold and marvellous works within man himself. The living activities of the cells of the body, the various processes that gather round cell metabolism and chemical reactions, and the part played by the endocrine organs in growth and development, are opening new fields and offering a more faithful clue to the causation of health and diseased conditions. True, biochemistry is still in its infancy. The maze of metabolic processes is still too intricate to follow or understand. The interrelation of endocrine glands, vitamines, enzymes, and hormones—words we use in our imperfect knowledge—are not fully unravelled. Yet they give us a glimpse, by the flickering light of which we thread our way to see their first principles. We see the barest outline, as biochemistry takes us step by step from the supply of raw food material, across the still unexplored regions of biological and chemical processes right up to the end of nutrition and the health of man.

Nutrition and respiration, as representing food and oxygen, stand at the very threshold of physical life. Food materials introduced into the body form the beginning of nutritive process, and the formation of healthy blood its last; and between the two lies the long chain of complex machinery we call 'metabolism,' which is concerned in vitalizing the food materials through the alimentary juices and secretions of various glands to bring about digestion, assimilation, and excretion. A break in any part in this long chain, any deficiency in the quantity and quality of food material, any fault or failure in the various secretory organs, will bring about abnormal changes in the chemical processes and reactions which, if continued, would ultimately lead to pathological and diseased conditions.

We may presume that growth and development, the health and well-being of man depend upon two sets of factors—various foodstuffs introduced from without and a host of chemical agents and reactions that operate upon them from within, and the interplay of these two principal factors gives a clue as to the main work of biochemistry.

Food Supply.—The study of tuberculosis, therefore, in the light of biochemistry, brings us to the examination of the food supply. In order to maintain health, all foods must contain a proper balance of proteins, carbohydrates, salts, and water. A certain quantity of food daily is also necessary to secure this balance and to replenish and to renovate the body, just as a cook in a house must be provided with a daily supply of provisions to prepare the meals and to feed the family. Proteins are not only tissue-forming foods, they have also a stimulating effect on various metabolic processes. Carbohydrates and fats supply kinetic and potential energy. Salts, found in all organisms, are the commonest salts of the earth, which regulate osmotic pressure and the alkalinity of the body fluids. And water—it is astounding that living matter, with all its wonderful properties of growth, movement, memory, intelligence, devotion, suffering, and happiness, should be composed of 70 to 90 per cent. of nothing more complex and mysterious than water![1]

But modern research has shown that an intake of a proper proportion of proteins, carbohydrates, salts, and water, is no longer sufficient to maintain life. The food values of a well-balanced ration may be perfect from a chemist's point of view, but physiologically may be far from perfect. It has been found that animals steadily declined in weight and health when they were fed with artificial foods based on caloric energy. Hopkins,[2] as early as 1906, showed that no animal can live upon a mixture of pure protein, fat, and carbohydrate, and even when the necessary inorganic material is carefully supplied, the animal cannot flourish. So we come to see that besides an intake of a certain quantity of food, a provision of a certain quality in the food, some accessory food factors or 'vitamines,' as Casimir Funk has called them, is absolutely necessary for the maintenance of normal health. Though the actual nature of these substances is not known, their existence is not doubted. Prior to the recognition of vitamines, the importance of the so-called glands of internal secretion had come to be recognized in the maintenance of a normal physiology. The inorganic constituents of the blood, such as salts, whose chemical properties are well known, should also come into the category of accessory food factors, as even in small quantities they are essential in the production of vital phenomena. With these, broadly speaking, can also be added enzymes and ferments, which are external secretions (while hormones are internal secretions), vitally necessary in promoting a healthy digestion and assimilation. So that, in a large sense, we may include the mineral salts, the vitamines, hormones, and enzymes in the group of accessory factors, which either supply materials that make for nutrition or act as stimulants and solvents of other foods—in other words, which either act as part of the food substance itself or serve as promoters of chemical assimilation of food substances.

Salts.—Calcium forms about three-fourths of the total mineral salts of the body,[3] and is an important mineral constituent of the food. It is necessary for the formation of cells, for the clotting of blood and milk, and for neuro-

muscular activity. Phosphate of lime enters into the normal structure of every organ of the body. Calcium in small doses stimulates the phagocytic activity of leucocytes,[4] and appears to play an important part in the metabolism of fats. During the period of growth and reproduction the organism requires the maximum amount of calcium. Sodium is concerned in tissue metabolism and the absorption of protein foods. The amount of sodium chloride in the human body averages about 200 grammes. Potassium salts are necessary for proliferating cells, especially for the development of cell life in blood and muscle. While sodium salts occur chiefly in animal foods, potassium salts are mostly found in fresh vegetables and fruit, and, being soluble in water, a considerable proportion of them is lost in the process of cooking. The importance of iron is seen in its forming a constituent of hæmoglobin, and therefore being essential for the absorption of oxygen by the system. Manganese is a valuable oxidizing agent and in conjunction with iron plays an important part in metabolism. Phosphorus is found where the growth is most active, and in the nuclei of all cells including leucocytes, in nucleo-protein granules, in tissue and nerve cells, and bones. The organs of the greatest vitality, such as the brain, the testes (for intellectual and spermatogenetic activities respectively), contain the most phosphorus. Its importance is so great that in its absence, as Bouchard said, not a cell in the body could be formed or could subsist.

All the mineral salts play an essential part in tissue building and nourishment. They may become deficient in the body through a deficient food supply and impaired metabolism, and also through increased acidity as a result of abnormal metabolism and deficient oxidation.

Vitamines are found exclusively in the tissues of plants, from whence they pass into the tissues of herbivorous animals, and thus become available for carnivora. So far three kinds of vitamines have been found. Fat soluble A is found in butter, cream, in the majority of animal fats except lard, and to a lesser extent in cod-liver oil, milk, eggs,

germinating seeds, green portions of plants, cabbage, lettuce, spinach, and carrots. Water soluble B, besides being an anti-beri-beri and anti-neuritic vitamine, is an important growth factor as fat soluble A, and is found most abundantly in eggs, wheat germ, and yeast, and in considerable quantities in liver, brain, sweetbread, wheat and maize bran, dried pulses, haricot beans, linseed and nuts, and in smaller quantities in lean meat, whole grain wheat, maize, rice, milk, and fresh green vegetables, such as lettuce, spinach, carrots, potatoes, and apples and lemons. Anti-scorbutic C—The richest sources of supply of this vitamine are raw cabbage, the juice of swedes and of turnips, fresh lemons, orange juice; and next in importance are the germinating pulses, fresh beans, scarlet runners, preserved lemon juice, fresh lime juice, raspberries, and tomatoes. This list of vitamines may not be complete, and probably more than one vitamine may be necessary for maintaining health.

Internal Secretions.—Though our knowledge of the functions and the chemical nature of internal secretions is still deficient, we know enough to maintain that they play a prominent part in the regulation of metabolism, growth, and nutrition. The thymus gland is the mother tissue of all lymphoid structures, and is associated with development and reproduction. The action of the adrenals and the sympathetic is reciprocal, for the sympathetic stimulates the secretion of the adrenalin, while adrenalin increases the sympathetic response.[5] The thyroid furnishes an internal secretion which is essential to normal growth and nutrition. It increases the functional activity of the adrenal glands, and through them general oxidation and metabolism.[6] The parathyroids, according to MacCullum,[7] control the distribution of calcium in the body. The pituitary body is associated with the reproductive organs and the sympathetic nervous system, and with growth, and is a stimulant to the plain muscular fibres and the secretion of milk. The pancreas is concerned in carbohydrate metabolism, and supplies ferments which take a direct part in protein metabolism of tissue cells; while the hormones in the

alimentary tract—gastric and duodenal secretions—together with the ferments produced by the liver control digestion, assimilation, and nutrition.[8] In fact, we may say in truth that every part of the body, including bones, muscles, brain, skin, etc., furnish an internal secretion necessary for the development and proper functioning of all the other organs of the body.

Enzymes.—Enzyme action is manifestation of all cell life, if not of life itself. Ferments and fermentation constitute life's activity and health, and their action in the living organism is due to their colloidal, electrical, and chemical nature, and not bactericidal as Pasteur affirmed. If there were no enzymes or ferments, there would be no life. They disintegrate and split fats, proteins, glycogen, etc., and oxidize them to form new compounds, and resynthesize amino acids. They reduce proteins into diffusible and easily oxidizable forms, so that they enter the cell and are built up into cell protoplasm, or become decomposed with the liberation of energy. All foods in their fresh, natural state contain enzymes which, acting upon the food materials, render them soluble. The enzymes of the digestive tract follow the work begun by the food enzymes. So both the food and body enzymes are necessary for complete nutrition.

Interrelationship of Accessory Factors.—We can go further and trace an interrelationship or dependency between the various factors we have been considering, between the proteins and carbohydrates on the one hand, and the four groups of accessory factors on the other. They act and react upon each other, and their co-ordination and antagonism create a healthy balance and normal metabolism. For instance, calcium metabolism, as well as growth and development, are under the influence of many endocrine glands, such as the thymus, the parathyroids, the pituitary, and the suprarenal glands. Sodium chloride stimulates the rate of lipase action. Ptyalin was shown by Bang (1911) to be almost inert in the absence of sodium chloride, while the activities of enzymes are greatly modified by salts, even in dilute solutions.[9] Fat soluble A is made up of labile

substances resembling those of an enzyme. Vitamines and hormones have many points in common. Vitamines are as characteristic of vegetable life as hormones are of animal life, and chemically they are not greatly dissimilar, while both are intensively effective in minute doses. That the lack of either may produce somewhat similar effects can be seen on comparing rickets (due to the absence of vitamine A) with osteomalacia; the neuritis of beri-beri (due to the absence of vitamine B) with that of diabetes; and scurvy (due to the absence of vitamine C) with the form of purpura due to acute adrenal deficiency.[10] There is good reason for believing that vitamines act as catalysts, also the enzymes whose action in many respects resembles that of inorganic catalysts, particularly in the colloidal state. McCarrison[11] has shown that vitamine and dietetic defects produce adrenal and pituitary enlargement, and atrophy of the other endocrine glands. The thyroid governs and controls all the other internal secretory organs. It stimulates the suprarenal, and both of them with the pituitary cause an increase of sugar through the sympathetic. All the endocrine glands interact with the reproductive organs and the sympathetic nervous system.

Colloidal and Electrical Action.—So far we have been discussing the chemical character of food constituents and food accessories. Chemical analysis alone does not determine the value of even the essential properties of foodstuffs; their colloidal and electrical conditions are intimately connected with their chemical reactions. Chemical action and electric phenomena are so closely related to each other that in many instances one cannot occur without the other. In fact, we are beginning to see that many phenomena which are generally regarded as chemical are largely electrical in character. The disassociation of a compound into its elements or ions is frequently accompanied by the assumption of definite electrical charges, as when common salt is made into a dilute solution with water it disassociates itself into sodium (positive) and chlorine (negative) particles or ions. The relation between colloidal and electrical condi-

tions is seen by the fact that all vegetable and animal fluids in the living tissues are largely colloidal in character, that the blood is a typical complex colloidal fluid, and that each colloïdal particle carries a definite charge of electricity.[12] The living cells which are largely impermeable become permeable under the influence of certain ions which allow electrically charged particles to pass freely through them. This passage of colloidal substances is considerably increased by the presence of a crystalloid such as common salt. Thus the colloidal, electrical, and chemical energies are closely interrelated. Electrical action energizes all physical and chemical processes, and gives potential, without which absorption cannot take place.[13] The structure of the body as well as of the plant, vegetable, and fruit is electrical, and chemical functioning is the expression of electro-physical activity in given media with constant charge, and that death, cellular or somatic, may be the expression of electrical diffusion.[14]

Experiments at Mendip Hills Sanatorium.—In this connection mention must be made of some experiments that were conducted at the Mendip Hills Sanatorium to ascertain the physical, chemical, and electrical condition of living foods and dead foods, and their relation to digestion and assimilation. The first set of experiments was made with the aid of an astatic galvanometer (as was recommended by Arthur Baines and A. White Robertson) to find out the electromotive force of fish, meat, fruit, vegetables, etc. When the positive terminal of the galvanometer was attached to a fine needle, which was inserted into the stem of a pea-pod, and the negative terminal to another needle which was inserted into the pod itself and the circuit closed, a deflection of positive sign was obtained, and on reversing the attachment to the galvanometer an equal deflection of negative sign was registered on the millimetre scale, and the electro-motive force of vegetable was thus found. So every fruit will give a constant negative deflection when the right hand needle is inserted in the stalk and constant positive deflection when it is inserted in the flower end. Fresh meat will give a re-

versal of sign within forty-eight hours, and after that time electric diffusion will take place. Fish loses the reversal of sign within a few hours after being caught alive. So in fruits and vegetables if diffusion takes place by injury, decay, or rot, there is no reversal of sign. When the foods are discharged of electricity they are dead. On the other hand, the seed bearing fruits and vegetables are vital foods and give the reversal of sign in proportion as they are alive and not wounded or bruised. These experiments go to show that the life of a vegetable or animal protoplasm depends upon its electro-motive force, and that the more they are stale or cooked the greater their electrical diffusion and death.

A second set of experiments was made on fresh foods, green foods, stale foods, and dried foods, with the help of a glass cylinder which was provided with a thermometer and which was placed in a sand-bath over a heating apparatus. Inside the cylinder a test-tube was kept constantly in motion by a clockwork movement, in which was placed dilute hydrochloric acid and pepsin in varying quantities. The heat was kept at a constant temperature by means of an automatic and cooling valve. All foodstuffs to be tested were carefully masticated in the mouth and placed in the tube, and the tests were made to represent as far as possible the digestion of the alimentary tract. (See chapter on Diet.)

From these experiments we gathered that fresh and quick (alive) foods retain their electro-potential with their vitamine and enzyme content, and that the physical properties of foodstuffs play a more important part in the process of metabolism and digestion than their actual chemical properties; rather the chemical properties are governed by the physical condition of food materials. The fresher the food the more intact its chemical, electrical and enzyme properties, the more easy and rapid its digestion and the greater its nutritive value. Fresh and alive and untampered foods bring with them their enzymes and ferments, which through their colloidal and electrical properties are isotonic with the ferments of the body glands and tissues, and hence their

meeting ensures a more normal and easy digestion and assimilation. In stale, cooked foods there is a deficiency and destruction of enzymes which not only render digestion more difficult, but produce purins and other toxins. It is, therefore, easy to understand why civilization is connected with deficiency diseases including tuberculosis.

If the condition and quality of the supply of raw materials are essential to a healthy nutrition, let us proceed to examine some of the staple foods that are daily consumed in an ordinary household—namely, milk, bread, meat, butter, vegetables, etc.

Milk.—The consumption of milk in civilized countries has grown with the advance of civilization, and forms an important article of diet for children and invalids. The foundation of a child's life is laid during the first six months or so of its existence when it draws all its nourishment from its mother's milk. Milk forms a complete food for the infant to whom its various ingredients have, weight for weight, a higher nutritive value than similar ingredients found in other foods. Milk proteins produce more flesh than the same weight of vegetable proteins and have a higher power of assimilation. So that the child that is breast-fed, and brought up in fresh-air surroundings, grows up to be a normal healthy being, as in the so-called savage and uncivilized lands where, in consequence, there is little or no tuberculosis among the children. But deprive the young infants of their natural food, rear them with cow's milk or any other artificial food, even under the best conditions you are introducing into them, who are struggling at the very threshold of life, materials foreign to their constitution and digestion. For all the ingenuity of man has not succeeded in converting the cow's milk into human. Only in recent times have we come to realize that human milk differs from cow's in many respects. Human milk is alkaline, while cow's milk is acid. Human milk contains more lactose, more substances of unknown nature, and less casein than cow's milk. The reaction of stools of artificially fed infants is alkaline and that of the breast-fed is acid, because in the

former fat and protein elements, and in the latter carbohydrates, predominate. In the breast milk lactalbumin constitutes two-thirds of the protein in the milk, while in cows it constitutes only one-fourth of the total protein.[15] Besides, the proteins of human and cow's milk are biologically dissimilar, so that those derived from the cow must be regarded as foreign to the human infant.[16] In cow's milk there is a large amount of fixed calcium, whereas in the human there is not much fixed lime, but a large proportion of free ionizable calcium.[17] In the breast milk there is a larger percentage (45 per cent.) of protective bacteria than in the bottle milk (37·6 per cent.) which prevent the development of pathogenic organisms To these physical and biological differences must be added the psychological effect when the mother feeds her child. The drawing of the infant to her bosom, and the caressing and fondling of it during nursing, with the feeling of the child's sense of security and satisfaction, must influence the sympathetic and stimulate the secretion of internal glands which ensure a healthy flow of milk and nutrition of the infant.

Investigations of Moro and Salge[18] go to show that greater natural properties of immunity are possessed by the breast-fed than the artificially fed. Therefore there is no wonder that the breast-fed child is better developed, goes through its teething and other ailments more naturally, resists infection more quickly and successfully, and has a lower mortality than the artificially fed.[19] Dr. Hope[20] has reported that the deaths among the bottle-fed children under three months are fifteen times as great as those found among the breast-fed. So that so far as the human milk is concerned there is conclusive evidence of its great superiority over any other method of feeding the infant, and yet there seems to be an unwillingness on the part of the profession to recognize that when a child is deprived of its natural food it is exposed to defective nutrition and all the train of evils that arise from it. This unwillingness is to a great extent due to a current belief that hand rearing does not very much affect the health of the child, and that there is no marked

difference in the nutritive value of raw milk and boiled milk; indeed, Lane-Clayton asserts that boiled milk has given her more favourable results than raw milk. But Price[21] showed that calves fed on raw milk did better than those fed on boiled, pasteurized, or sterilized milk. If, according to Moro and Finklestein,[22] the gain of weight of children is inferior when fed upon boiled human milk, surely we can infer that boiled cow's milk must be inferior to raw milk. There is a great deal of evidence that heat destroys nutritive and biological properties. Also the inhibitory effect of protective substances found in raw milk is destroyed by boiling, with the result that bacteria grow more rapidly in the boiled than in raw milk. The germicidal action of raw milk has recently been demonstrated by Chambers,[23] who found by combined evidence of microscopical examination and plate count an actual decrease in numbers of bacteria in raw milk under certain conditions. It may be possible in a laboratory to regulate the amount and duration of heating milk to a scientific precision so that it does not lose very much of its nutritive and biological qualities; but how is it possible to ensure a strict laboratory condition in an ordinary household where the mother or the maid of all work has many duties to perform besides standing over a stove and watching the temperature of milk? Investigators have concluded that ordinary cooking, or even the pasteurizing process, is liable to weaken or destroy the anti-scorbutic and other valuable properties of milk, so that infants reared on such sterilized or boiled milk are liable to suffer from rickets. From our own practical experience at the Sanatorium we found that patients did not thrive on sterilized milk, and so had to give up sterilized and substitute fresh milk. On heating, small amounts of H_2S are split off from the milk which may account for the change in taste and odour, and when the flavour is destroyed at least some of the nutritive properties are likely to be destroyed.[24] On the other hand, Hopkins[25] has shown that when rats are fed on an insufficient dietary the addition of minute quantities of raw milk caused a most striking difference in the rate of growth of the animals. Cow's milk is

intended to rear a calf and not a human child endowed with all the high qualities of mind, intelligence, consciousness, etc. If we seriously think for a moment of the enormous difference that exists between a child brought up under natural conditions and carefully tended and nursed by the love and devotion of its own mother and the unfortunate one tucked away in a perambulator and left to feed itself from a bottle of artificial food, the composition of which depends day by day upon the caprice of its attendant, we shall come to realize the terrible disadvantage of the hand-reared infant whose constitution must seriously suffer at the most formative period of its life. The general assumption that tuberculosis begins in early childhood obtains a new interpretation —viz., the evils of substituting artificial feeding for breast feeding is the first tragedy of the civilized child which brings in its train gastric derangement, malnutrition, and other constitutional disturbance.

Bread.—The study of the history of bread-making reveals another tragedy of civilization. From the earliest history of the world bread has been described as the staff of life. More than fifty years ago the countrysides of England were dotted with stone mills where locally produced grain was ground for the making of bread. Hand mills are still found in many parts of Asia, India, France, etc. When the wheat was milled between stones, the flour contained the unimpaired enzymes of the grain and produced bread which nourished fine healthy people of good physique, sound constitution, and perfect teeth. The grain of wheat contains among other things protein, carbohydrates and starch, fat and enzymes. The nutritive parts of the grain can only nourish the body if they are acted upon by the enzymes in the grain and dissolved, so that they may be easily absorbed into the system. The wheat grain contains four kinds of enzymes: cerealin, which causes the protein of the wheat to become soluble peptones; amylase, which converts the starch into sugar; cellulase, formed during germination, which converts cellulose into sugar; and an enzymic fat soluble which assists to emulsify the fat. The roller mill was introduced into England in

1862, and from that time dates the degradation of our daily bread. The millers found the flour which contained the unimpaired enzymes inclined to go rancid if it was kept after two months, and so they proceeded to bake the wheat grain to destroy the enzymes, in order that the flour might be kept longer than Nature has intended. Even the ordinary 'brown bread,' which is made by the addition of a little bran to the rolled flour, is no better or more digestive, as the constituents of the bran cannot be assimilated without the aid of the enzyme 'cellulase.'

The bread that is made of non-enzymic flour has been found to impair nutrition and health, and predispose to disease in both man and beast. T. G. Read,[26] who has given considerable attention to the study of food enzymes in relation to health, has shown by his experiments that young chickens, when fed on meal baked to destroy the enzymes, suffered from diarrhœa, and died within a fortnight of being hatched; laying hens, fed solely on baked grain, soon stopped laying; pigs fed on stale barley-meal, in which the enzymes had perished, fell ill of swine fever and died; but when the pig-keepers ground their own meal which contained the unimpaired enzymes, they never lost an animal from swine fever. Reid further observes that the peasants of Normandy and Brittany chiefly live on pot-au-feu (consisting of various vegetables, meat, fish, stale bread, slices of cheese, and rind of bacon) and bread containing all the enzymes of the grain. They are mostly tall, of fine physiqué, and sound teeth; whereas the inhabitants of Jersey, who are also descended chiefly from Normans and Bretons, lived on imported chilled beef and frozen mutton, and bread made from roller flour where the grain enzymes have been destroyed, have decayed teeth, and are not as tall nor have as fine a physique as the Normans and Bretons. These observations are corroborated by workers in biochemistry, who attribute the decay of teeth to some vitamine deficiency in the diet of children and adults. The non-enzymic bread simply fills up the stomach without nourishing the body. The destruction of food enzymes

reduces the nutritive value of the food and lowers the vitality of the people.

Rice.—Here again one sees the evil effects of Western civilization. As long as the inhabitants of the East, untouched by the Western habits, subsisted on whole rice they did well. The working population, to whom rice is a staple article of diet, did hard physical work and kept itself strong and healthy. But with the arrival of modern milling machinery from the West, the brown rice was milled and polished, and was robbed of its silver skin together with the germ or embryo; and this white polished rice is a deficient food, and those who live wholly on it succumb to beri-beri. Hopkins quotes Eijkman,[27] who found that for each 10,000 of the prison population in the Dutch East Indies, there was only one case of beri-beri among those eating unpolished rice, 416 on the mixed rice dietary, and no less than 3,900 on polished rice.

Meat.—Enormous quantities of frozen meat are yearly imported to England for home consumption, and the poor especially avail themselves of this imported meat, owing to its being cheaper than the home-killed meat. The nutritive value of frozen meat is reduced, owing to the loss of meat-juice and volatile substances which give aroma and flavour and render meat appetizing. Well-nourished dogs fed on frozen meat suffer from dysentery and eventually die of it, as the enzymes of the meat are more or less destroyed when kept in the cold storage. Nansen[28] found that fresh meat without vegetables was sufficient to prevent scurvy, whereas monkeys can be given the disease by feeding them on stale meat. Fowls fed on sterilized meat or sterilized egg will develop polyneuritis.[29]

Vegetables, Fruits, etc.—Fresh vegetables and fruits form important sources of salts and vitamines. In large cities and towns it is difficult to obtain fresh-cut vegetables, as by the time they reach the ordinary household they become stale and tend to lose some of their electrical properties. Vegetables as daily articles of diet owe their chief importance to the alkaline salts, especially potash, they contain;

and as the potassium salts present in vegetables are soluble in water, a considerable proportion is often lost in the process of cooking. Fresh fruits also contain salts of potash and antiscorbutic vitamines. Chick and Hume[30] have reported that all dried foods examined, including desiccated vegetables, are more or less deficient in antiscorbutic vitamine; cooking cabbage at 110 to 120° C. destroyed decidedly more of the antiscorbutic property than ordinary cooking. Drying destroys entirely, or reduces, the anti-scorbutic property of a vegetable. Holst and Frolach[31] found that potatoes, carrots, dandelions, and cabbage lost all, or the greater part, of their antiscorbutic property for guinea-pigs through long drying. Scurvy is cured or averted by the addition of fresh raw cabbage to the diet, but it has no effect upon symptoms if even twice the amount of the same vegetable is given cooked or 'high dried.'[32] The potato has a high content of potassium. Carrots have a considerable amount of both water soluble and fat soluble vitamines. A considerable portion of the caloric value of food is lost when water used in cooking is thrown away. Rats fed on cooked carrots without the extracted juice soon developed a tendency to eat a larger amount of food than rats which were fed with boiled carrots plus the juice in which they were cooked.[33] From our own experience we have found that a diet of fresh home-killed meat, fresh-cut vegetables, and new milk, is more satisfying than the same amount of chilled meat, stale vegetables, and boiled milk. Appetite and flavour are Nature's way of indicating the quantity and quality of food necessary for nutrition. There is no doubt that the consumption of large quantities of food in vogue in civilized countries is partly at least due to the eating of foods which are more or less devoid of vitamines and essential substances that make for nutrition.

All foods that have been treated with heat or cold and preserved are electrically dead foods, and hence have more or less lost their nutritive value. We do not notice their loss in a mixed diet, but in countries where the diet is confined exclusively to a single cereal—as in the rice-eating com-

munities of the East—the deficiency of nutrition becomes apparent. So civilization, to a large majority of the population, involves the consumption of cooked and dried foods, frozen and tinned foods, refined and polished foods, stale and preserved foods, which are foods deficient of vitamines and other food accessory factors which disturb nutrition in the long run and bring about conditions of malnutrition and disease.

Before going further, we must notice one or two points that bear on deficient accessory factors. Not only deficiency in food accessory substances, but deficiency in hygienic conditions, would also help to disturb metabolism and nutrition. Young chickens fed on normal diet, but reared indoors and kept under laboratory conditions and deprived of liberty and fresh air, failed to develop and declined.[34] Fresh-air conditions stimulate metabolism, as seen in the sanatorium patients, whereas bad hygienic conditions help to intensify the effects of food deficiency. Drs. Daton, Findlay, and Watson,[35] making experiments on some litters of dogs, found that all the first litter they sent to the country, where the puppies could romp and play and were fed on oatmeal porridge and skimmed milk, thrived and had no rickets; but the second litter that was confined in the laboratory and fed on wholemeal porridge, whole milk, and butter fat, showed distinct signs of rickets. Again, a mere supply of raw materials does not ensure of their being utilized by the organism; they must be presented in an organic form, so that they can be easily metabolized and absorbed. Mineral substances in the human milk, such as phosphorus and calcium, are in an organic form, and are therefore easily assimilated. Any deficiency of calcium from a deficient supply of milk to children cannot be made good by adding to the dietary vegetables such as spinach or carrots, which are rich in calcium content. The latest studies by Denis and Minot[32] indicate that it is difficult to enrich the human blood by giving calcium salts in this way. Cow's milk contains 5 per cent. of calcium, and yet children fed on this lime-laden food get decayed teeth; yea, a large amount of calcium salts

may actually promote toxic results[36]—all this showing that the utilization and metabolism of calcium and other salts depend upon the way they are introduced as raw materials into the body organism.

Food Accessory Factors and Disease.—From the foregoing observations it is abundantly clear that if the daily diet is deficient in one or more food essentials, metabolism must suffer, and diseased conditions would, sooner or later, make their appearance. We can only relate briefly the morbid conditions that are related, directly or indirectly, to food deficiencies.

Salts.—Young animals deprived of potassium show retarded muscular development. Scurvy in adult animals has been attributed to the absence of potassium salts, and this idea received support from the beneficial effects of fresh vegetables and fruit in that disease. Sir F. W. Mott[37] finds that in the central nervous system in dementia præcox there is degeneration of the nucleus of the neuron, and, in all probability, a diminution of organic phosphorus in the cell in the males. Calcium starvation is associated with many morbid conditions, such as joint troubles, rickets, epilepsy, tetany in eclampsia and pregnancy, etc. Sir James Barr[38] found that one of the earliest signs of pneumonia is the diminution of lime salts in the urine. Faulty digestion, as well as faulty diet, produces lime starvation in man. J. F. Russell[39] states that insufficient supply of lime leads to imperfectly developed organs, lowered resistance, and lack of power to repair injury. Loeper and Bechamp[40] found that certain chronic intestinal diseases cause a loss of calcium, and from this arise symptoms such as asthma, loss of weight, decrease of coagulation, hæmorrhage, nervous disturbances, and that in gastro-intestinal lesion the calcium content of blood is decreased. Deficiency of iodine would bring thyroid disturbance and all the evils connected with thyroid insufficiency. Depletion of alkali reserves produces acid intoxication and a host of troubles associated with it. In fact, mineral salts play such an important part in metabolism and nutrition that it is impossible to trace all the morbid con-

ditions they induce by their deficiency in quantity or in assimilation by the organism.

Vitamines.—The researches of Funk, Hopkins, McCarrison, McCollum and Davis, Osborne and Mendel, Mellanby, Chick, and many others, have shown the tremendous influence exerted by vitamine deficiency in producing many disorders. The deprivation of fat soluble A develops rickets, osteomalacia, or keratomalacia in infants. The deprivation of water soluble B is responsible for beri-beri and polyneuritis; while the deficiency of antiscorbutic vitamine is associated with scurvy, and of protein with pellagra. It is interesting to observe that in both pellagra and leprosy there is loss of sensibility and blanching of the skin, and a profound disorder of nerves and nerve centres, and both are caused by some toxic character of the food—the one of bread and porridge, and the other of fish (Hutchinson) or animal food (Creighton).[41] Chick's experience among the starving children of Vienna has shown that besides the various stages of delayed growth and development, malnutrition and Barlow's disease are brought about by deficiency of vitamines and other food factors. Further, dietetic deficiencies, as McCarrison[42] has pointed out, lead to many gastric and intestinal derangements, such as dilatation of the stomach, gastric ulcer, colitis, dysentery, etc. Also deficiency of vitamines affects the efficiency of all the endocrine organs, and through them brings about a larger circle of disorders, which result in degenerative changes in every organ and tissue of the body.

Endocrine Organs.—It is not possible to separate altogether the effects of vitamine deficiency from those of endocrine insufficiency. One intensifies the condition of the other. Besides, there is such an interdependence between the endocrine organs themselves, that the affection of one is an affection of all the rest. Broadly speaking, endocrine insufficiency profoundly affects the metabolism of the body, and growth and nutrition. It is well known that severe forms of thyroid insufficiency develop cretinism and myxœdema, and arrest growth and development in children.

Between malignant and benign myxœdema there is a wide range of thyroid insufficiency affecting the cutaneous, gastro-intestinal, nervous, and sexual systems, and producing symptoms of infiltration of tissues and nerves, rheumatism, hæmorrhage, loss of hair, dry skin, subnormal temperature, enuresis, intestinal stasis, and toxæmia, etc. In fact, the symptoms of thyroid degeneration are so extensive as to affect almost every tissue and organ of the body and almost every civilized family. And so with regard to adrenalin, there are various degrees of hypoadrenalism leading to asthenia with low blood pressure, lack of vascular tone, weak cardiac action and pulse, anæmia, slow metabolism, physical and nervous prostration. The insufficiency of parathyroid is connected with tetany, of pancreas with varying degrees of diabetes, of duodenum with intestinal disturbance. Deficiency of endocrine and sexual organs causes general depression, melancholia, neurasthenia, and many other forms of neuroses. And all the morbid conditions produced by vitamine and pluriglandular insufficiency affect, and are affected by, the great sympathetic system, involving a wider circle of disturbance of all the vital processes of the body, and creating various diatheses that afflict mankind.

Tuberculosis and Deficiency of Food Accessory Factors.—Tuberculosis is fundamentally a disease of lowered nutrition and of decline in functional activity of cells and tissues. Though the investigations of biochemistry concerning their relation between deficiency of food accessory factors and tuberculosis are not fully worked out, the evidence of all the available material goes to show that tuberculosis is truly a deficiency disease—a disease accompanying a deficiency in quantity and quality of food materials, deficiency of assimilation and nutrition, deficiency of hygienic conditions, of physical and mental rest, etc.

Deficiency of Protein and other Caloric Factors.—In a large majority of cases, tuberculosis is developed under conditions of poverty and chronic want, whose effects are intensified in every generation. The grim tragedy that is

being enacted on a large scale before our very eyes in starving Vienna and other devastated districts of Central Europe speaks louder than all scientific arguments to prove that underfeeding and chronic starvation result in malnutrition, lowered vitality, rickets, and tuberculosis.

Deficiency of Food Accessory Factors.—Salts, vitamines, endocrine and enzyme deficiency.

Deficiency of Salts.—Many authorities agree that calcium starvation is one of the features of tuberculosis. According to Gaube, there is in tuberculosis 0·22 less mineral salts, especially phosphates, than is found in normal adults. Halverson, Mohler, and Bergeim[43] state that failure of the body to deposit lime around the tuberculous areas is due to an inability of the tuberculous area to utilize properly all the available calcium. What is the cause of this inability? Calcium starvation in the body may be brought about not only from deficient food supply, but also from deficient assimilation and destruction of free calcium ions by acid fermentation. Again, calcium phosphate being insoluble, its absorption is best assured when it is in chemical union with proteid substances; the action of the enzyme, rennet, causes the chemical combination of lime phosphorus and casein, and the action of pepsin is necessary to prepare this combination for absorption in an assimilable form. The formation of rennet from zymogen is dependent upon the presence of hydrochloric acid in the gastric juice, so that if the gastric secretion is deficient in hydrochloric acid and gastric ferments lime starvation ensues; and as tuberculosis is closely associated with gastric derangement, J. F. Russell's theory that calcium starvation is at the root of tuberculosis seems quite probable. His theory is strengthened by the fact that tuberculosis follows many acute fevers, gastro-intestinal disorders of children and adults, pregnancy, lactation, etc., in all of which calcium metabolism is impaired by deficient gastric secretion. Also this may be the rational explanation of the general improvement in our sanatorium patients, which follows the administration of an hydrochloric acid mixture. Anyhow, there seems to be a very close

connection between gastric disturbance, calcium metabolism, and the appearance of tuberculosis.

Hart, Steenbock, and Humphery,[44] after making careful experiments, found that the mere addition of calcium to the fodder of cows prevented the birth of premature, weak, or dead calves. The investigations of Forbes have shown cows producing large amounts of milk, and fed with common winter rations, undergo constant losses of calcium, magnesium, and potassium from the body, so that a large number of milch cows suffer from deficiency diseases[44] which open the door to tuberculosis.

Selkirk[45] invariably found that cement labourers and lime-kiln workers are immune to lung infections. Also T. J. Beasley,[46] commenting upon the relation of calcium deficiency and tuberculosis, points out the infrequency of the disease among lime workers, and recommends the administration of calcium chloride.

According to Wells,[47] the amount of iodine in the thyroid is decreased in tuberculosis, which may be the reason why thyroid insufficiency and tuberculosis often go together.

Deficiency of Vitamines.—In all the chief cities and towns in civilized countries where tuberculosis is most prevalent vitamineless food forms the chief articles of diet, especially among the poor. The stale, the frozen, and tinned foods are deprived of much of the aroma, volatile substances and vitamines, and cooking them still further reduces their nourishing properties. In literally thousands of poor families men, women, and children live chiefly on white bread, margarine, jam, tinned milk, and tea, which are so deficient in nourishing elements that it is impossible to form healthy blood, bone, and tissue from such a vitamineless diet. To this must be added the monotony of the same diet, year in and year out, and the crowding together in slums, tenements, and one-roomed dwellings, where decent conditions are impossible—all these factors tend to impair digestion and metabolism and lead to malnutrition and wasting diseases. Professor Johnson observes that the absence of vitamines

not only causes atrophy of muscles and degeneration of nerves, but is a predisposing cause of tuberculosis.

Deficiency in Endocrine Organs.—As we have seen, endocrine glands are the great regulators of nutrition and metabolism. According to Hutinel,[48] there is thyroid, suprarenal, and pituitary deficiency in tuberculosis. Wasting diseases are associated with a considerable decrease in the size of the thyroid, and with this a decrease in the amount of iodine. The ancient humoral theory, which attributed life and resistance to the healthy blood and plasma, is really the present endocrine theory, which places the mechanism of vital resistance largely in the thyroid, the suprarenal, and the pituitary glands. Sergent[49] has described two forms of adrenal insufficiency occurring in tuberculosis. The first deals with the well-defined symptoms of Addison's disease; in the second the symptoms of adrenal insufficiency become more marked as the disease progresses. The caseation and calcification occurring in tuberculous foci in the lungs are due not merely to an increase of lime through the ingestion of suitable food, but also to increased functional efficiency of the adrenal glands. Toxæmia is the usual cause of adrenal insufficiency, and in tuberculosis the amount of toxin is larger than the adrenal can cope with. Endocrine glands, with or without their association with the nervous mechanism, supply the proper stimulus for all the activities of digestion, nutrition, and assimilation. Endocrine insufficiencies, as the thyroid in parents, may show themselves as tuberculosis in the children; or pulmonary tuberculosis and thyroid degeneracy may so act and react upon each other that it may be difficult to ascertain which is the cause and which is the effect.

Deficiency of Enzymes.—Many, if not all, of the chemical activities of the body cells are due to the enzymes they contain. Enzyme action is the most important factor in maintaining nutrition and neutralizing toxins. In tuberculosis the secretions of the entire digestive tract are more or less diminished in quantity and quality, followed by disturbed metabolism and decline of body nutrition. Especially the liver and pancreas

show functional insufficiency in tuberculosis. Defective pancreatic secretion involves defective oxidation and acid production, and enzyme deficiency brings gastro-intestinal fermentation and putrefaction. Deficient nutrition, which is characteristic of tuberculosis, may be brought about by deficiency of both food and alimentary enzymes. For the enzymes of the digestive tract alone cannot maintain complete nutrition, they must have the co-operation of the enzymes from the food materials. For instance, in the white bread which is daily eaten in civilized countries, the enzymes which render the nutritive parts of the grain soluble are destroyed, and hence ptyalin alone in the saliva is not sufficient to convert all the starch of the bread into sugar. Owing, therefore, to the want of oxidizing action of the grain enzymes, nascent lactic acid is formed in the mouth, which acts upon the enamel of the teeth and causes caries. Also, owing to the inability of the enzymes of the digestive tract to digest cellulose, fat, and carbohydrate of the grain, much of the nourishing materials of the food, which would have been assimilated if the food enzymes had been active, is either lost and evacuated by the bowels, or accumulates, forming a bulky mass, causing constipation and stasis. So that poverty means deficient food, deficient nutrition and assimilation owing to deficient enzymes which cause deficient oxidation and acid condition, accumulation of by-products of digestion, and constipation and a greater amount of work laid on the ferments of the digestive organs. In the well-to-do classes, rich living, overeating, alcohol, with a sedentary life, impose a still greater burden on the liver and pancreas, and a greater amount of secretion of enzymes both for digestion and destruction of toxins; the consequence is that in the course of time there ensues fatigue, exhaustion of pancreas, and other digestive glands, dyspepsia, acid intoxication, and various diathetic conditions.

Milk and Tuberculosis in Children.—The hand-rearing of infants has become almost universal in civilized countries. The enzymes of human milk are just suited to the stomach of the child for healthy digestion and assimilation. Cow's

milk does not contain the ferments needed by the infant's digestion, but contains a foreign protein[50] which its digestive organs find difficulty to absorb and assimilate as readily as the milk of its own mother. This itself is a great tragedy. With the development of bacteriology came pasteurized, sterilized, boiled, and finally dried milk, in which bacterial life is more or less thoroughly destroyed, and yet the disease of malnutrition remained. Marasmus, rickets, infantile scurvy, osteomalacia, recurred in spite of the use of bacterially purified milk in children, because these foods had lost something which fresh milk contained. (*a*) Boiling, sterilizing, etc., have destroyed at least some of the enzymes and antigens found in the fresh milk which made for digestion and absorption, and which conferred a high degree of resistance to the growth of pathogenic organisms. (*b*) While boiling left the organisms of contamination unharmed it has destroyed to some extent the protective bacteria found in fresh milk, such as lactic acid bacilli, which protect the infant from the possibility of putrefactive changes occurring in the intestines, and permit the digestive process being carried out in the natural way. (*c*) In human milk lactose is more abundant than in cow's, which is food for the lactic acid bacilli. Thus the hand-reared infant is deprived of the friendly offices of the lactic acid organism. This is another tragedy. The feeding of the infant with gruels, dextrinized flours, starchy foods, further harasses its digestion and nutrition, as the amylotic enzymes of saliva and pancreatic juice are not developed properly until many months after birth, so that it cannot assimilate these artificial foods which contain a great deal of starch. This is still another tragedy. Added to these it meets with other troubles, such as being brought up under bad hygienic and insanitary conditions, slums, overcrowding, and as it grows its digestive struggle with vitamineless foods, such as white bread, margarine, tea, etc., still more undermine its nutrition. The consequence is that while the savage child that is breast-fed grows free from tuberculosis, the hand-reared infant develops gastro-intestinal affections characterized by dyspeptic stools, emaciation, loss

of appetite, loss of weight, followed by malnutrition, rickets, and tuberculosis, which are the outcome of wrong feeding and underfeeding as seen by the terrible amount of these diseased conditions among the Austrian and German children at the present day.

So all through the history of civilization man's natural food is tampered with and nutrition suffers. The milk is boiled and sterilized, the butter concocted from vegetable fats, the wheat is milled, the rice hulled, the maize decorticated, the oats rolled, the potato peeled, the vegetables boiled, the fish and meat chilled or tinned, the sugar refined, etc.

These are more or less dead foods which are wanting in vital elements that make for a sound body and healthy life. As dead foods man is obliged to eat a larger quantity of them which only increases the gastric and intestinal trouble, with the result that all the organs are overworked, the stomach is dilated, the process of digestion impaired, and ends in a condition of acid intoxication and intestinal stasis —a condition so ably described by Sir Arbuthnot Lane,[51] who affirms that intestinal stasis and chronic constipation develop changes in and reduce the activity of the thyroid.[42] It is true that toxin absorption from the bowel would reduce the activity of endocrine glands, but, as McCarrison showed, we must go behind intestinal stasis and connect both imperfect assimilation, chronic constipation as well as thyroid deficiency with vitamine and enzyme deficiency. The toxins associated with chronic intestinal stasis lead to nutritive failure and tuberculosis. Many hundreds of cases of pulmonary tuberculosis begin from gastric trouble, and as time goes on the failure of digestion and nutrition still more intensifies the disease or causes its recrudescence. Therefore, looking at the whole question, we can conclude that evidence is accumulating to show that vitamine and enzyme starvation lead to disorders affecting the gastro-intestinal, endocrinic, sexual, nervous, in fact every system in the body, so that we can truly say that all diseased conditions are the outcome of, or associated in the first place with, deficiency of food, or some food accessory factors.

Disease seen from Biochemical, Biological, and Bacterial Aspect.—So far we have been studying disease from the viewpoint of food deficiency and biochemistry. But biology takes us a little further in its explanation of the phenomena of life and its variations. It points out that there is an inherent law of life by which an organism adjusts itself to various environments. In a simple way life solves its own problems by its functional activity. The processes of life carries with it the processes of diseased conditions, and the process of disease becomes the process of healing. So that the law of healing already exists in disease in the same way that a rise in the carbonic acid gas in the blood carries with it an adjustment in the increased breathing. If the quantity of salt taken with the daily food, as Haldane[52] pointed out, is very small, the kidney does not secrete very much of sodium chloride; but if the quantity consumed is large, the kidney secretes more, and so whether we take little or much salt with the food, the same osmotic pressure is maintained in the cell. Again, if there is an increased acidity of the blood, it is counteracted by quickened breathing and increased consumption of oxygen, which washes out the surplus CO_2, and by the production of ammonia instead of urea by the liver. Thus the organism is constantly adapting itself to the varying changes in environment. In reality life, health, disease, immunity are just continuous adaptations to maintain harmony and equilibrium. The reactions that maintain life when healthy heal life when that health is disordered; in other words, the law of healing is already present in the disease.

Life with its functional activity not only adapts itself when nutritive processes are maintained, but also when nutrition is impaired through a deficiency of food materials. Voit[52] has pointed out that blood during prolonged starvation retains its normal composition, and more fat is oxidized to compensate for the deficiency in albuminous oxidation. So is disease, like tuberculosis, an adaptation to new conditions. If health can be termed the ordinary plan of war campaign which a general follows in the course of the war, disease

can be likened to his alternate plan which he keeps in his pocket to be used should a crisis arise and the first plan prove unsuccessful, but both plans are already thought out, the one in operation and the other waiting to be carried out, and in both the same materials, such as troops of cavalry and infantry, guns and ammunition, etc., would be used, perhaps only grouped and arranged differently or in greater numbers. So in disease Nature uses the same chemical reactions to bring about healing as in health. The symptoms which arise in disease are part of the curative process of nature, and tuberculosis, which in its first phase can be considered physiological, carries with it the cure of the disease in its fever, inflammation, caseation, fibrosis, etc. But when the stress of war is continued the deficiency of oxidizable materials is prolonged, the functional adaptive changes pass on to structural changes, and structural to more or less permanent organic changes, then in reality disease is ushered in, which is an expression that Nature has failed in her strenuous efforts to maintain an organic order. Short of these degenerative changes pathology is part of biology, and disease in the first stage is an adjustment already in the settled plan, and symptoms of tuberculosis are part of its cure.

Disease, Tuberculosis, and Bacteria.—(*a*) Such a biochemical and biological interpretation of disease gives a new angle of vision on many of the problems of tuberculosis. In this light we discern a new relation between disease and bacteria. All the foregoing considerations will enable the reader to understand that food deficiencies prepare the soil for bacterial growth. McCarrison[53] has pointed out that imperfect digestion brought on by vitamine deficiencies affords a favourable medium for the growth of bacterial organisms. Not only gastric disturbance and intestinal stasis, but almost every disturbance and disorder in any part of the body is due directly or indirectly to some food or vitamine deficiency or starvation. Micro-organisms seem to make their appearance after the pathogenic process has set in. The bacteriologists would fain see an infective origin in such diseases as

scurvy, pellagra, beri-beri, acute yellow atrophy, œdema, pernicious anæmia, goitre, eclampsia, colitis, diabetes, gout, etc., but experimental observations have shown unmistakably that bacterial organisms appear in the arena of disease secondary to the changes in the organism from deficiency or derangement of nutritive processes. One would therefore conclude that bacteria mostly make their appearance as the result of some biological or pathological changes which are in their turn due to nutritional or some vital disturbance arising within the body.

(*b*) Further, Nature's behaviour towards diseases associated with micro-organisms is not different from that of other diseases not so associated. She does not bring any new or specific action against bacteria as such. The reactions by which she defends herself against bacteria are not developed as a specific measure of defence against bacteria alone, but are reactions against all foreign proteins of similar nature, whether bacterial, animal, or vegetable.[54] All foreign proteins when introduced into the circulation of animals are more or less toxic, and toxic effects of bacterial toxins for the most part are neither specific nor particularly striking. Also products of autolysis, cleavage products, proteose of leucocytes may themselves be toxic and can cause fever. Symptoms of suppuration, such as chills, fever, etc., are due to autolytic products rather than to bacterial poisons, as aseptic suppuration is also accompanied by fever, etc.[55] Vaughan[55] showed that typical fevers can be produced by enzymatic disintegration of body proteins. The fact that the injection of enzymes acts like a poison, causing fever, trembling, uneasiness, hæmorrhage, and even death[56] (that these effects are due to the enzymes themselves rather than to contaminating bacteria is shown by Kionka and by Achalme, who obtained similar results with enzymes made sterile by filtration through porcelain), gives a clue that the effects of bacterial injections are due to their protein rather than their specific nature.

(*c*) The pathological processes brought about by histological, autolytic, or physico-chemical changes which are

caused by food and enzyme deficiencies are chemical processes, and the defence of the body is also chemical and biological. The action of the enzymes of the digestive tract by its acidity of gastric juice, alkalinity of the bile, pancreatic juice, etc., neutralizes and prevents the absorption of bacterial and other poisons, and what is not dealt with by the alimentary tract is destroyed by the enzyme action carried on in the blood and tissues. Nature treats bacteria as a foreign protein in the same way that she does other foreign proteins received through food, and defends itself by its enzymatic action which disintegrates these proteins and renders them inert. So by the simple and natural processes such as elimination, as in alcohol, by combination with substances formed or contained in the tissues, by chemical alteration, oxidation, reduction, hydrolysis, and neutralization, it overcomes the diseased conditions, bacterial or otherwise.[57] Bacteriologists have long considered that immunity reactions are reactions by which the body defends itself against bacterial infection and are specific; but now we know that the reactions of animals to infection are not specially devised for combating bacteria and their products, but can be equally exerted against non-bacterial cells and their products.[58] These reactions are chemical, not bacterial, and the problems of immunity are chemical problems.[59]

(*d*) We can go still further and suggest that Nature, besides using physiological and biological means in diseased conditions, may press into its service both saprophytic and pathogenic bacteria to restore life and health. We have been so biassed against bacterial organisms that we have not sufficiently recognized the beneficent part they play in the restoration of the health of the organism.

Though the links in the chain of argument pursued in this chapter between biochemistry, food deficiency, and tuberculosis, may be wanting here and there, we have produced sufficient data which strongly suggests that diseased conditions arise mostly from fresh air, food, and vitamine deficiencies which create morbid and pathological changes which favour bacterial growth, that symptoms of

disease and immunity reactions are physiological adaptations to restore the normal, and that bacteria themselves may take a part in the process of recovery.

But man is more than meat and drink, more than proteins and food accessory factors. Life flows on beyond bacteriology and biochemistry, and beyond biochemistry there are other factors of tuberculosis which will be dealt with in the succeeding chapters.

REFERENCES.

[1] Physiological Chemistry, by Matthews, p. 12.

[2] Professor F. Gowland Hopkins, in *Analyst*, 1906.

[3] John F. Russell, *Medical Record*, November 27, 1909.

[4] Hamburger, Editorial in *Journal of Amer. Med. Association*, October 25, 1910.

[5] W. Langdon Brown, *Brit. Med. Journal*, November 6, 1920.

[6] E. de M. Sajous, *Practitioner*, February, 1915.

[7] MacCullum, *Brit. Med. Journal*, November 6, 1920.

[8] The *Practitioner*, January and February, 1915.

[9] *Science Progress*, January, 1921, p. 416.

[10] W. Langdon Brown, *Brit. Med. Journal*, November 6, 1920.

[11] Lieut.-Colonel R. McCarrison, *Brit. Med. Journal*, August 14, 1920.

[12] Colloids in Health and Disease, by Alfred B. Searle.

[13] Studies in Electro-Physiology, by Arthur E. Baines.

[14] Studies in Electro-Pathology, by A. White Robertson, p. 74.

[15] 'Infant Feeding,' by Mark S. Reuben, *Medical Record*, New York, August 4, 1917.

[16] 'Breast- and Bottle-Fed Babies,' *New York Med. Journal*, October 12, 1918.

[17] Sir James Barr, *Brit. Med. Journal*, July 31, 1920.

[18], [19] Milk and its Hygienic Relations, by Lare-Clayton.

[20] Dr. Hope, Forty-Second Annual Report of the Local Government Board, 1912-13, p. 84.

[21], [22] Same reference as [18] and [19].

[23] Chambers, *Journal of Amer. Med. Association*, March 21, 1921.

[24] Physiological Chemistry, by Matthews, p. 313.

[25] Hopkins, in Milk and its Hygienic Relations, by Lane-Clayton.

[26] Thomas G. Read, the *Medical World*, February 7, 1919, and the *Vegetarian*, 1917, 1918, and 1920.

[27] 'Eijkman,' by Hopkins, *Brit. Med. Journal*, April 26, 1919.

[28] The Newer Physiology in Surgical and General Practice, by G. A. Rendle Short.

[29] *Journal of Hygiene*, March, 1918.

[30], [31], [32] 'The Antiscorbutic Property of Desiccated and Cooked Vegetables,' by Givens and Cohen, *Journal of Biological Chemistry*, October, 1918.

[33] 'Feeding Experiments with Raw and Boiled Carrots,' by Denton and Kohman, *Journal of Biological Chemistry*, November, 1918.

[34] J. C. Drummond, *Biochemical Journal*, March, 1916, p. 77.

[35] Purdy, *Medical Review of Reviews*, New York, August, 1920, p. 429.

[36] *Journal of Amer. Med. Association*, March, 1919, p. 656.

[37] Sir Frederick W. Mott, *Brit. Med. Journal*, December 6, 1919, p. 741.

[38] Sir James Barr, *Brit. Med. Journal*, March 23, 1907.

[39] The Treatment of Tuberculosis based on the Assumption that the Dietetic Cause of the Disease is Lime Starvation, by John F. Russell.

[40] Max Kahn, 'Calcium Therapy in Tuberculosis,' *New York Medical Record*, May 23, 1914.

[41] Evolution and Disease, by J. T. C. Nash.

[42] Lieut.-Colonel R. McCarrison, *Brit. Med. Journal*, July 31, 1920.

[43] 'Calcium in the Blood in Tuberculosis,' by Halverson, Mohler, and Bergeim, *Journal of Amer. Med. Association*, May 5, 1917.

[44] Alfred Hess, *Journal of Amer. Med. Association*, March 12, 1921.

[45] Selkirk, *Journal of Amer. Med. Association*, December 12, 1908, and J. R. Mitchell, *New York Medical Record*, August 5, 1911.

[46] T. J. Beasley, *New York Medical Journal*, July 21, 1917.

[47] Chemical Pathology, by A. Gideon Wells, pp. 595, 596.

[48] Hutinel, 'Syphilitic Dystrophies of Infants,' in *Archives de Médecine des Enfants*, January, 1920.

[49] Sergent, *Gazette des Hôpitaux*, July 11, 1912.

[50] Milk and its Hygienic Relations, by Lane-Clayton, p. 31.

[51] 'The Evolution of Disease,' by Sir Arbuthnot Lane, *Lancet*, December 20, 1919.

[52] The New Physiology, by Dr. Haldane.

[53] The Influence of Deficiency of Accessory Food Factors, by Lieut.-Colonel R. McCarrison, July 12, 1919.

[54] Chemical Pathology, by A. Gideon Wells, 1918, p. 165.

[55] *Ibid.*, pp. 92-93.

[56] *Ibid.*, pp. 61-62.

[57] *Ibid.*, pp. 59 and 245-246.

[58] *Ibid.*, p. 214.

[59] *Ibid.*, p. 165.

CHAPTER IX

THE PHYSIOLOGICAL FACTORS OF TUBERCULOSIS

'Disease does not differ in principle from life.'—VIRCHOW: *Cellular Pathology.*

'Nature is the physician, not thou. Thou must learn of her, not of thyself.'—PARACELSUS.

IN the previous chapter we have seen that deficiency diseases, such as scurvy, beri-beri, rickets, pellagra, etc., are closely related to vitamine deficiency, which not only causes impaired or deficient nutrition, but also creates a toxicity which leads to pathological conditions.

1. But vitamine deficiency and impaired nutrition do not lead straightway to diseased conditions. In experimented animals which are artificially fed, where vitamine deficiency is purposely rendered severe and intensive, and in acute starvation and underfed children, the morbid effects may be seen very quickly; but in natural conditions, and in man taking a mixed diet where deficiency in one food factor is made up by partaking of another, and where small deficiencies may take a long time to develop, there is a considerable interval between physiological and pathological processes. Mere financial difficulty of a man does not mean his bankruptcy; he often succeeds in his efforts to tap every available resource and meet his liabilities. It is only when his embarrassment becomes chronic and prolonged, and repeated endeavour to increase his assets fails, does a real crisis arise. So even when a pathological condition is set up Nature may make a stupendous effort to restore the lost equilibrium. Medical men have been so taken up with the study of bacteriology, that they have not paid sufficient attention to the teaching of higher physiology and biology

which reveals Nature's wonderful schemes of adaptation to meet every normal and abnormal condition. If health is Nature's first intention, cure or arrest is its second intention, but in both there is the same principle of adjustment to environment; and it is only when Nature fails to adjust itself to abnormal conditions that disease takes a pathogenic character. Life is response to ordinary healthy resistance. Both the emptying of the bladder and the uterus at the full time are a physiological response to resistance caused by their fulness. In diseased condition there is a greater resistance which Nature overcomes; but whether in normal or greater resistance the adjustment is physiological in the first instance.

2. The beginning of almost every diseased condition may be considered physiological. Inflammation and fever are the response of the organism to bring about healing. A grain of sand falling on the eye causes congestion and exudation by which Nature gets rid of the foreign body. So all congestions and exudations may be considered Nature's way of eliminating some poison or undesirable element injurious or detrimental to the system. So also can be considered skin eruptions, such as boils, carbuncles, eczema, etc., spots of exanthemata, urticaria, diarrhœa, dysentery, hæmorrhage, sweating, etc. In all deficiency diseases congestion and hæmorrhages are common. It is only when the spots are suppressed instead of coming out, as in some cases of measles, smallpox, etc., that a danger arises in the system which may prove fatal. The writer has noticed many cases where patients enjoyed better health after measles, scarlet fever, or some other eruptive fevers. In one case a patient, after a severe attack of scarlet fever, got rid of his rheumatism from which he suffered for many years. So also pleurisy, pneumonia, gout, rheumatism, etc., may be looked upon as Nature's effort to get rid of some poison or toxin from the body. Only when the condition which first caused the mischief becomes persistent and permanent, and Nature's efforts become more and more feeble to remove the obstacle involving a change in the composition of the blood and the

constitution, can a state of pathological condition be said to arise.

3. Tuberculosis can be truly called a physiological process at the beginning. The very fact that all the stages of the disease, including consolidation, breaking down, cavitation, fibrosis, and formation of cicatrices, can take place in the system silently, without any outward indication or symptoms, without even the knowledge of the patient, suggests its physiological character. Just as in a temporary financial breakdown of a firm the business goes on in the usual way as it has plenty of floating assets to draw from, and even its most intimate and confidential servants are unaware of the crisis, so Nature cures and arrests the disease in tuberculous patients in thousands of cases without their knowing that there was anything wrong with them. Again, in the condition known as scrofula, where there is low vitality, inflammatory state of the skin and mucous membrane, enlarged lymphatic glands, anæmia, cachexia, thyroid deficiency, Nature succeeds in balancing the assets and liabilities—this condition can also be termed the physiological phase of tuberculosis, or better still, can be placed in the buffer state between physiology and pathology, where the majority of the children riddled with tuberculosis of glands seem to get well. What we instinctively and blindly make out as a difference between infection and disease is in reality a difference between physiology and pathology. Tuberculosis is a lifelong process; many crises, with or without manifest symptoms, may arise during the lifetime of civilized man, and at each successive time Nature makes greater and greater effort to overcome the abnormal condition, and so long as there is ample reserve of strength the signs and symptoms, such as temperature, nightsweats, breaking-down, caseation, and fibrosis, form part of the healing process, and the patient healed more than once. But if he still persists in his old vicious environment and pursues his strenuous life, his vital energy slows down, the physiological condition passes on to a pathological state. When the same symptoms appear in an aggravated form, he seeks advice of a physician

and enters a sanatorium, and open-air conditions give another opportunity for the organism to recuperate itself and repair the disease.

4. Thus the course of the disease itself is one of the important conditions for healing—*i.e.*, the law of healing is already present in disease like the embryo in the seed-grain.[1] Inflammation and fever are a healing process of an active nature, and the very increase of heat is used by the organism for definite curative purpose. True, fever brings a greater disturbance in abnormal conditions than in health, just as there is a greater disturbance in running than in walking; but the point is, that the process of fever and inflammation are necessary for the arrest of disease, the danger arising only when Nature's activity ceases and temperature falls. Though the action of enzymes is not definitely known, and the myriad activities in Nature's secret laboratories are obscure, this much we do know through biochemistry—that physiological processes are marked by chemical actions and reactions, whereby the enzymes and ferments dissolve and digest the food materials, decompose, neutralize, and oxidize the by-products of digestion, rendering them inert or ready for assimilation; and so in diseased conditions the organism using the same enzymes and ferment action against the toxic materials neutralize or oxidize them into harmless substances. Also inflammatory fluids and exudates are dissolved by autolytic enzymes which split them into various products before they are absorbed or eliminated from the system. So many of the chemical and physiological processes carried on in the body, though they seem complex and confusing, may be fundamentally identical. The chemical action may after all be very simple—the body receives food materials, the proteins split into diffusible and easily oxidizable forms, so that they may enter the cell and be built into cell protoplasm; the foreign proteins, disintegrated and digested in the alimentary canal through enzyme action, which also forms on the way new substances to defend the body against any toxins, and all the activities expressed in terms of antibodies, antigens, precipitins

agglutinins, complements, etc., may be nothing more than results of digestion and products of metabolism. Besides the inflammatory and enzyme action, the body may make use of bacteria in the process of repair and restoration. Bacteria themselves produce autolytic products which are powerfully bactericidal.[2] Possibly bacteria may be responsible for the decomposition of the fats rather than the body lipase.[3] Knapp[4] holds that in pus the cocci and the enzymes they produce are responsible for much of the digestion. Pus cells alone do not undergo digestion so rapidly as when bacteria are present, and digestion is more rapid if bacteria are alive than when inhibited or killed by antiseptics—showing that Nature utilizes the offices of bacteria to disintegrate pus cells, and to carry out the scavenging process of elimination. The very toxins of bacteria, like enzymes, may go to render substances inert, or split to form new compounds which are necessary for the animal economy. Anyhow, though the ways of Nature to establish equilibrium and harmony still seem mysterious, and though reacting substances are not accessible to chemical investigation, we know enough to affirm that the body processes of health and healing are largely a matter of enzyme action, alimentary digestion, and normal metabolism.

5. **Bacteriological and Biochemical Views of Disease.**—Such a chemical and physiological conception of diseased condition comes into sharp conflict with the bacteriological view that disease is caused by a specific action of a micro-organism, and that immunity both for cure and prevention can only be obtained by inoculation with a specific organism or specific antitoxin. As already shown, biochemistry has broadened our vision, enabling us to see that many of the chemical activities of the body cells in health and disease are due to the enzymes they contain, and that disease may be due to want of or inhibition of enzyme action, and that oxidation is an important process in defending the body against toxins by making them inert and harmless. Also, bactericidal substances may be products of digestion and metabolism, and chemical activities, such as oxidation, reduction, hydro-

lysis, neutralization, etc., are Nature's means by which it meets all foreign proteins and toxins (including bacteria). Enzymes and toxins behave very much like each other[5]—which makes us surmise that they are the products of the same cell from different stimuli, the healthy stimulus secreting an enzyme, and the unhealthy secreting toxin as the result of absence of an enzyme or of its inhibition by the sympathetic—in the same way that mammary cells which produce healthy milk at one time produce also toxic milk from an outburst of anger or fright. At any rate, whether the toxins are produced by the body or bacterial cells, they are likely to be destroyed in the alimentary tract by gastric juice, bile, pancreatic juice, etc., or undergo oxidation and neutralization, though we are in the dark as to how chemical oxidations are accomplished.

So what is called bacterial action may be really chemical and biological, and the immunity reactions a process of enzyme action, of metabolism and digestion; so also anaphylaxis is but an exaggeration of the normal process of defence of the body against foreign proteins (including bacteria) through digestion.[6] There is no evidence that symptoms of disease are due to bacterial toxins, but there is evidence to show they are the effects of a greater activity of the organism to meet the increased resistance. The contention that injection of bacteria or their toxins induces fever and other constitutional symptoms is no proof of the specific activity of bacteria, as the injection of healthy enzymes, and for that matter, of any foreign protein, causes fever, trembling, hæmorrhage, and even death. There is no proof that the organism creates specific substances to meet bacterial toxins; the reactions which it brings into play against toxins are developed against all foreign substances, whether they are animal, vegetable, or bacterial.[7] As we have seen, it treats bacteria as a foreign protein, and the animal body is continually receiving in its food foreign proteins against which it defends itself by enzyme action which disintegrates these proteins.[8] The organism acquires tolerance to such drugs as morphia, alcohol, etc., but there

seems to be no special serum created to neutralize their toxic effects, and why should it treat bacteria in a different way? The immunity reactions are neither specific nor bacterial, but chemical and physiological. The organism can form a large quantity of antitoxin and yet have no immunity, and conversely, in cases of natural inherited immunity, no antitoxin at all is formed.[9] So that the various processes by which the organism adapts itself in health and diseased condition should be interpreted in biochemical and biological rather than in bacterial terms.

6. **The Physiological Basis of Tuberculosis.**—In constructing the various physiological steps that lead to tubercles and tuberculosis from the findings of biochemistry and biology, we start with the effects of vitamine and food deficiency, impaired metabolism and malnutrition.

(*a*) **Impaired Nutrition.**—Cow's milk, food deficient in vitamines, and dead foods when they cause toxic effects in the system, or the injection of tubercle bacilli—they all behave like foreign proteins. In children the gastric organs are ill-adapted to digest cow s milk, and in old age the effects of feeble digestion are added to those of defective vitamine and food deficiency leading to gastric derangement. Many a gastric crisis in children from improper feeding and disordered nutrition ushers in meningeal tuberculosis, and tuberculosis in the adult and old age is very much associated and aggravated by gastric trouble. Metabolism is also interfered with by bad hygienic and insanitary conditions, devitalized air, slums, overcrowding, etc.

(*b*) **Defective Blood Formation.**—Stale air and stale food, defective food and vitamine supply, and defective nutrition, lead to defective blood formation, both in quantity and quality. That blood is the seat of life and vital resistance is the humoral theory of the Ancients. At least it is the reservoir of living fluid which supplies food and energizes every cell, tissue, and organ. Nutrition and respiration combine to enrich blood for the distribution of oxygen to every cell of the body. Any impairment in its composition will affect the quality of its cellular or chemical element or

fibrin-forming substance, and especially the red corpuscle whose function of conveying oxygen will be imperfectly performed; and the first to suffer from the impaired quality are the blood-making and blood-renewing organs—the lymphatic glands, the liver, spleen, and bone marrow—together with endocrine glands.

(*c*) **Blood Dissolution and Disposal.**—If the causes that bring about the alteration of blood continued, two sets of important changes would take place. (*a*) The altered quality of blood, decreased oxidation and accumulation of metabolites, including CO_2, follow one another, and will lead to physical and chemical changes in the vessel wall, causing the softening of endothelium, dilatation of vessels, and slowing of circulation, which will still more increase the disturbance of oxidation and accumulation of acids, producing swelling, viscosity of blood, arrest of circulation and stasis.[10] (*b*) The red corpuscles owe their basicity to proteins,[11] and if proteins are not well formed as a result of digestion, red cells cannot neutralize the acids which in turn lower their resistance, so that owing to their lowered resistance and imperfect formation the red cells become susceptible to phagocytosis. Nature tends to destroy anything that is badly formed, as in the case of a hen mother which kills the newly-hatched chicken if it is sickly or injured; so the injured red cells are pricked out of the blood chiefly by endothelial cells of liver, spleen, lymphatic glands, etc., where they undergo hæmolysis.[12] The stasis leads to congestion, thrombosis, hæmorrhage, extravasation of blood, dissolution, and phagocytosis of red cells by leucocytes, and endothelial cells of blood-forming organs. In this reduction (the obsolescent red discs are worked up in the laboratory of hepatic cells to form new combinations) their pigment is split up by the liver, the non-ferruginous part goes to form bile, and the pigment and the iron are used up to make new hæmoglobin. The other residues of the red cells, together with the phagocytic cells which have engulfed them, go to form opaque granular epithelioids and giant cells, which eventually undergo caseous degeneration; hence the origin of tubercles, epithelioid, and giant cells.

Tubercles, as Creighton[13] pointed out, are therefore Nature's way of disposing of the remains of red cells and other detritus that are undesirable in the system, exactly as it casts off the skin eruptions, nettle rash, purpura, rashes in zymotic fevers, etc. Any serious disturbance in nutrition or abnormal state of blood may lead to a crisis and the formation of a crop of tubercles which the organism would dispose of in a natural way either by absorption or caseation, and many crises of a similar nature would tend to form in time a tubercular diathesis, and only when its strength begins to fail after a long-continued struggle to maintain health and equilibrium does physiology pass on to pathology. Such a physiological picture reconciles many biological and biochemical facts in connection with tuberculosis, and is the only rational mode of explaining the spontaneous arrest of tuberculosis, cases of hæmorrhage in the early stage, the cure of advanced tubercular peritonitis by opening the abdomen and letting out any fluid, and many other clinical facts. So the difference between health and disease, between physiology and pathology, is only one of degree, the pathological activities being more intense, though of the same kind.

REFERENCES.

[1] The Inherent Law of Life, by F. Kleinschrod, p. 91.

[2] Chemical Pathology, by Wells, pp. 102 and 119.

[3] *Ibid.*, p. 411.

[4] Knapp, *Zeitschr. f. Heilk.*, 1902, p. 236.

[5] Chemical Pathology, by Wells, p. 67.

[6] *Ibid.*, p. 198.

[7] *Ibid.*, p. 165.

[8] *Ibid.*, p. 170.

[9] The Inherent Law of Life, by F. Kleinschrod, p. 135.

[10] 'Factors Governing Vascular Dilatation and Slowing of the Blood-Stream in Inflammation,' by Paul G. Woolley, the *Journal*, Index Number, December 26, 1914.

[11] *Archives of International Medicine*, vol. ii., 1908, p. 336, by James Ewing.

[12] Chemical Pathology, by Wells, p. 229.

[13] Contributions to the *Physiological Theory of Tuberculosis*, by Creighton.

CHAPTER X

THE BIOLOGICAL, EPIDEMIOLOGICAL, PSYCHOLOGICAL, AND ETHICAL INTERPRETATION OF TUBERCULOSIS

'To explain mechanically means to explain by external causes.'—KANT.

'The effect can never be explained by outer causes nor Nature ever be interpreted by outer causes alone.'—HUME.

WHEN the study of biology, with its law of evolution and development, is applied to diseased conditions and micro-organisms, we seem to get a clearer insight into the etiology of tuberculosis. Biology lays down the broad principle that an organism is closely related to its environment—in fact, Haldane[1] asserts that environment is part of the organism—that there is no permanency in the physical structure of a cell; that life, from the highest to the lowest, is undergoing a perpetual change, and is constantly adapting itself to the varying conditions of environment. The mutation of micro-organisms, which can be demonstrated in quite a number of instances, has made untenable the theory of Koch and other bacteriologists that pathogenic organisms are specific entities. On the other hand, biology has shown that micro-organisms are subject to evolution and are influenced by the soil in which they are cultivated, and assume special properties according to environment. In fact, environment determines their shape, pigment production, virulence, and every other property. Since there can be no permanence in environment, there can be no constancy in specificity. The evolution of pathogenicity from the saprophytic stage is seen in such cases as the water spirillum or the harmless coli organisms becoming in course of time cholera or typhoid organisms, and the evolution into harmless saprophytes, as

in chicken cholera, demonstrated by Pasteur, when exposed for a long time to the air, or in many other cases through long-continued cultivation, change of culture media, etc. We have already seen that man, through nutritional deficiency and impaired metabolism, creates a soil favourable for the growth and development of organisms within his body.

Plant Pathology.—In this connection it is interesting to observe the close analogy that exists between the vegetable and animal kingdoms. Nutrition influences both the health and the chemical composition of plants. Just as both poverty and plenty bring about an inefficiency which, in the long run, leads to tuberculosis, so the susceptibility to disease among plants can be brought about by want of, or excessive fertilization with nitrogenous manures. The resistance of the vegetable cell is lowered by adverse nutrition when its cell wall is softened, the old and fully developed cuticle of the plant is no longer proof against parasitic enzymes, and bacteria which actually exist upon the surface of the leaves in millions as saprophytes begin to injure the cells and favour disease. This finds a parallel in the animal cell, where vitamine deficiency causes increased permeability of the vessel walls, as in the case of scurvy. Laurent's[2] researches with bacillus coli communis on potato tubers show that it is necessary for the tubers to be deprived of their resistance before the virulence of the organism can be induced, that the virulence is increased by their successive cultivation upon tubers of slight resistance, and disappears as soon as the organisms are cultivated on a living healthy tuber. The uninjured plants are quite impregnable to attacks of plant bacteria. Nutrition may so alter a facultative saprophyte that it becomes a virulent parasite, which in turn may lose this virulence through other nutritional changes. It is also shown that respiratory activity of injured cells is less than in uninjured cells, and that the increased production of CO_2 at a wound was traced to the activity of bacteria living upon the uninjured cells. The fact that parasitic disease of plants is only brought about as a result of some altered nutrition, injury to their

cells, and lowered resistance, gives a clue that in the animal world also nutrition and vital resistance govern the development of bacteria and disease.

Epidemiology.—The study in the behaviour of the variation of micro-organisms and disease, including tuberculosis, leads us to inquire into the prevalence of epidemics and the factors that produce them. The epidemiologists are not agreed as to the causation of epidemic visitations. The bacteriologists, of course, bring in their germ theory, and attribute all epidemics to contagion. The more progressive among them, recognizing the variable character of micro-organisms, hold that the periodicity of epidemics is due to some altered virulence of bacteria in different seasons and climates. Others do not hold with the contagion theory, and associate the prevalence to seasonal, climatic, and atmospheric conditions, while the sanitarians find the cause in insanitary and unhygienic conditions. Statistical and bacterial explanations are not reliable. The attempt to connect epidemics with specific micro-organisms has not been successful. We are so obsessed with the germ theory that we must drag it in even where there is no possible connection between disease and infection. Farr and Simon[3] have shown that conditions of human life—environmental and eugenic—are quite as important as the *materies morbi*. The aerial transmission of disease is not so popular as once it was, and Hamer[4] has shown that the 'carrier' theory associated with typhoid has no scientific foundation. The spread of typhoid has long been attributed to infection by milk, and Hamer says that a careful enquiry in London during the last twenty-five years brought to light only one outbreak in which a *prima facie* case against milk was established, and even in that instance the conclusion cannot be regarded as free from doubt. He concludes that it is due to the consumption of polluted shell-fish and ungutted flat fish. Since they are generally bought by the poor for cheapness, typhoid becomes more an economic question than contagion as in many other epidemics. In the case of puerperal outbreak, has not Semmelweis[5] laid down the

principle that it is not contagious from one person to another, and that no disease could be the cause of puerperal fever unless it produced a decomposed animal matter which must be conveyed direct to the healthy puerpera? As for plague, Major Gloster and Major White,[6] who investigated the spread of plague in the Central Provinces in India, have shown that humidity during winter months is so regularly associated with severe epidemics of plague, that they are fully justified in concluding that one stands to the other as cause and effect. It is curious that though the black rat preponderates over the brown in the plague districts, the brown rat is more frequently affected than the black variety—showing that it is not because of less infectivity, as is alleged, but the greater resisting power of the black rat that immunizes them more than the brown. It is still more curious that the writer has seen outbreaks of plague in India in districts where there was not the slightest sign of a rat, and Dr. Farrar,[7] alluding to the Manchurian plague of 1911, also states that not a single infected rat was found in the invaded areas, though careful search had been made for such. Evidently we can have plague without rats in the same way that we can have tuberculosis without tubercle bacilli, or malaria without mosquitoes.

When Sydenham[8] emphasized the 'epidemic constitution' he must have believed that the prevalence of epidemics was due to the constitution of the atmosphere, seasonal variation, or some meteorological condition. When he defined epidemics 'as acute diseases generated by a secret and inexplicable alteration of the air infecting the bodies of mankind, and only conditioned by a peculiar crasis of the blood and humours,' he must have had an idea that epidemics had something to do with the changes in the condition of the blood. That the prevalence and spread of epidemics are largely influenced by filth, insanitation, and uncleanness is proved by the fact that they rage fiercely in poor, overcrowded, and ill-ventilated districts and slums devoid of fresh air and sunlight, and that when such insanitary areas are cleared the epidemics lose their virulence and disappear.

Above all, it is well known that plague and pestilence, typhus and cholera, follow the wake of wars and famines when there is much starvation and underfeeding. The widely prevalent typhus in Poland during the recent great war was shown to spread where there was dirt, destitution, and overcrowding. The writer has seen that virulent epidemics of plague and cholera were due to shocking insanitary conditions, overcrowded houses, and congested latrines prevailing in the poor Indian quarters, aggravated by poverty and unemployment. Creighton[9] raised the question whether some toxic property of the staple food might not have had an originating influence in the epidemic and psychopathic phenomena in the Middle Ages, and traced some epidemics in France (in the Middle Ages) to eating bread made of the spoilt rye-crop or other grain. If a disease like scurvy is seen in an epidemic form, it may be due to an epidemic of some vitamine deficiency prevailing among a large number of people, as witnessed among groups of soldiers in the late war. So that while the origin of epidemics may still remain obscure we can recognize one or two conditions in which they arise. Social, economic, dietetic, and mental factors loom largely in some epidemics. There seem to be two sets of causes that operate on their prevalence—the external, such as the climatic, atmospheric, insanitary and unhygienic; the internal, such as want, destitution, and faulty nutrition: and both of them influence disease through impaired metabolism. The seasonal prevalence may be the effect of Nature to cleanse the system from toxins that have accumulated during the long winter from excessive consumption of nitrogenous foods, deficiency of vitamine or green foods, or from any other excess or fault in diet. At any rate, the condition of acidosis is a constant factor in all infectious fevers, and in the great epidemic of influenza in 1918 acidosis was particularly present—resulting in impaired oxidation, acid intoxication, and faulty elimination of poisons which favour the soil for micro-organisms and disease. Seasonal disease may therefore be due to seasonal variation in food and metabolism. In-

flammatory and congested conditions, eruptive fevers, influenzal colds, bronchial catarrhs, etc., may be Nature's way of trying to remove the toxic condition of the blood, just as menstrual discharges are said to be the means by which a woman rids herself of poisonous matters from the blood—an ancient belief lately corroborated by Professor Schick[10] of Vienna; and so epidemics may act like spring and autumn cleansing of the body. The thunder in the air causes the sourness of the milk, showing that atmospheric and electric conditions favour the growth of some bacteria. The seasonal variations of epidemics are therefore more likely to be influenced by man's external and internal environment than by the biological variations of micro-organisms—rather, bacterial variations depend upon man's environment. In other words, the rise and fall of epidemics has a closer relation to man's living conditions, his social habits and environment, his mental outlook and attitude, than to micro-organisms. It is not so much the life-history of bacteria as the life-history of man that the mass phenomena of epidemics are concerned with.

Brownlee's Epidemiology of Phthisis.[11]—In this connection we must draw the attention of the reader to John Brownlee's enquiry into the epidemiology of phthisis. His elaborate statistical research enables him to distinguish three types of the disease occurring in the adult, the middle, and late life, which correspond to three separate types of bacilli. To the clinical student tuberculosis presents, instead of three, a great variety of types and phases which cannot be classified and tabulated under any definite groups. If the difference in the types of the disease corresponds to different age periods—the adult, middle, and old age—it is more likely due to man's different social and economic environment, or to some want of right adjustment of the various endocrine organs in those age periods, than to various types of tubercle bacilli. Brownlee thinks that there is no evidence that diphtheria is either more prevalent or more fatal in crowded districts, and he even doubts whether scarlet fever is more prevalent in poor districts; but

Ewart,[12] who analyzed sixty-four rural districts in the Eastern Counties in 1911-13, found a considerably positive correlation between the attack rate of scarlet fever and the percentage of population living more than two to a room. In India it has been recognized that at least plague and cholera are more prevalent in crowded and insanitary areas than in other places. So also in tuberculosis there is a positive correlation between density and the death-rate. For instance in Dundee[13] the death-rate from pulmonary tuberculosis in houses of one room was 74.4 per 10,000; in two rooms, 64 per 10,000; in three rooms, 55.2 per 10,000; in four rooms and upwards, 32 per 10,000.

The apparent contradiction between Brownlee and Ewart can be reconciled by the assumption that overcrowding operates as a factor in the spread of a disease only when it is an index to poverty, poor nutrition, and lowered metabolism. Brownlee further finds that in adults the phthisis death-rate in the London boroughs is not positively correlated with hygienic surroundings, but it is with poor feeding and damp and wet conditions, because, it seems to us, that growing manhood would be sensitive to feeding and climatic conditions; it wants food more than fresh air, and when healthy nutrition is secured, the evils of overcrowding would take a secondary place in influencing the death-rate. Clinically we have seen not only in adults, but in middle-age working-classes, that as long as they secured employment, good wages, and good nourishment, they were free from tuberculosis. That nutrition is a more important factor than overcrowding is, perhaps, the reason why in Christiania[14] the death-rate from tuberculosis has steadily diminished in spite of its shortage of houses and consequent overcrowding, while in thinly populated districts of Norway[14] it is increasing at a tremendous rate. Whereas Brownlee's middle-age group, which has passed the stage of growth and development and fear of unemployment, and immuned to climatic conditions, would be likely to be affected by the growth of families, involving overcrowding and lowered hygiene. Again, Brownlee finds that the middle-age group

does not seem to be affected by wind. In London, for instance, there is no more phthisis on the high exposed parts, such as Hampstead, than in the more sheltered parts of the Thames Valley. But Gordon[15] of Exeter has collected a mass of evidence to prove that populations exposed to strong prevalent rain-bearing winds tend to suffer considerably more from phthisis than sheltered populations. In our own experience we find that patients feel better when they are exposed to constant movement of air and cool bracing atmosphere, which improves their metabolism and well-being, and as they improve in health they seem able to stand almost any wind, except, perhaps, moist or north-easterly winds. It is, as Leonard Hill says, the exposure to warm, windless, or humid conditions of atmosphere that affect their spirit and lower their metabolism and health.

The prevalence of a factor like strong winds need not necessarily be the cause of phthisis. Wind exposure, as Hamar[16] has pointed out, would not only affect men but also the land, involving less fertility of the soil—as the land exposed to winds and high altitude are not very productive—the decrease of the population, and many other social conditions. The factors in a disease like tuberculosis are so complex and interrelated that it would be a fallacy to attribute the death-rate solely to one cause. Also, no statistics can bring out all the bearings of etiological factors. It cannot take into consideration all the human elements and the living issues with their endless varieties of conditions that make for disease. No two cases of tuberculosis are alike in history, temperament, resisting power, the course and extent of disease, and in the result. If men were so many uniform bricks we could calculate to a mathematical certainty the quantity of bricks required to build a wall. But life is intangible, and its operations are elusive and not uniform or fixed so that it cannot lend itself to statistical analysis or mathematical tabulation. Brownlee himself sees the difficulty, and says that 'statistics alone will not give the solution.' It is the biologist, the biochemist, the psychologist and the sociologist, rather than the bacteriologist and

the statistician, that can throw light on problems of tuberculosis.

Tropical Races and Tuberculosis.—The spread of tuberculosis among the tropical races lends colour to the theory of contagiousness of phthisis, and seems to justify the term 'epidemic' as applied to tuberculosis, but when the question is probed deeply we seem to get a different view. The dark races are simple children of Nature, living a primitive life on a lower plane, and blessed with an indolent peace and social freedom and absence of care in clothing, eating, and drinking; but bring them into contact with the strenuous people of the West, take them out of the fresh air, rob them of their freedom and immure them in gold and diamond mines, dump among them speculators, planters, gold-diggers, convicts, and the refuse of European communities, debauch them with vice and immorality, and rouse their primitive instincts by tempting them with rifles and drink—these unprotected people are unable to adapt themselves in such a bad atmosphere, their primitive moral habits are not strong enough to stand the strain of such a violent change of environment, and hence their floodgates are open to all the European vices, and they succumb to alcohol, syphilis, and tuberculosis. It is not the geographical position, or the heat, or the climate, or even sanitation, that can account for the spread of tuberculosis among the different races in the East, for they had all this physical environment before the Western civilization came among them. The Samoans[17] belong to a vigorous, robust, and well-developed race, and the American Samoan has very little tuberculosis, but his neighbours, the French Samoans, among whom the French have established a penal colony, is demoralized by coming into contact with the discharged convicts with their low morals, alcohol, prostitution, and other excesses, and hence is being decimated by tuberculosis. Even the current idea of a virgin soil as being the cause of the rapid spread of tuberculosis among the dark races should be imputed not to an impaired physical soil, but first to a depraved moral environment, brought on by the collusion of two

different standards of living and thinking. Like children, the mental and moral qualities of the primitive races being undeveloped, they are easily influenced, and easily fall victims to a vicious environment imported by the Western people. Among them, as elsewhere, a disturbed mind causes impaired metabolism and nutrition and diseased conditions. If some races, such as the Africans, the Negroes, and Polynesians, are more prone to tuberculosis, it may be because of their racial emotional nature, which is not strong enough to have a controlling influence over the effects of the new ferment of Western thought. This emotional or psychological factor may be one of the reasons why, among the Europeans, the Celts, the Irish are more liable to tuberculosis than their Teutonic neighbours. The difference in the temperament and mental and psychic outlook, by influencing metabolism and nutrition, would account for the difference in the clinical course of the disease among the various races rather than the different types of tubercle bacilli. It is only by studying tuberculosis from the human factor, rather than the germ factor, that we shall get a true insight into the cause of the disease among the tropical people as among the Western races.

Tuberculosis in India.—In this connection, a word or two may be mentioned with regard to the prevalence of tuberculosis in India. In recent years tuberculosis has made considerable progress in India, especially in big congested cities, in the large manufacturing, commercial, and religious centres, where poverty, overcrowding, and insanitation prevail. In fact, the mortality in cities like Bombay and Calcutta is considerably higher than in Glasgow, Birmingham, and Manchester.[18] It is spreading into the villages, into educational and boarding institutions, among the poor living in mud houses or in slums and squalor of crowded towns, among the Parsees, Indian Christians, and students who have adopted Western customs with regard to food, clothing, etc , and among Anglo-Indians in humbler circumstances. It is more prevalent among the female than the male population, owing largely to vitiated and insanitary

conditions of the *Zenanas*. In all the big cities it is estimated that tuberculosis mortality varies from two to three (and more in some cities) per thousand.[19] Basing our calculation on the lowest death-rate (two per 1,000) of the population of the whole of India (315 millions*) we obtain an annual death-rate of 630,000. About half the total recorded deaths in India (about seven millions) is attributed to various fevers, of which, according to Sir Leonard Rogers and Stewart,[20] 9 per cent. is due to tuberculosis, thus adding another 315,000 deaths. So that we reckon the total annual death-rate from tuberculosis cannot be less than nine hundred thousand to a million in India. The factors that have brought such a widespread distribution of tuberculosis in India have a parallel in this country, when it became a victim to economic and industrial revolution in the early fifties. The contact of the East with the West has caused great social, economic, industrial, moral, and spiritual upheavals, as seen in the growth of towns and cities, the expansion of trade and commerce, the depopulation of villages, decay of home industries, migration into towns, high rents and dear food, overcrowding and insanitation, poverty, want, intemperance, and degeneration. These have resulted in an insufficiency of light and fresh air, of food and accommodation, of rest and repose of mind, which have lowered the vital powers of the people and widely opened the door to tuberculosis. As regards milk, the prevalence of tuberculosis, in spite of the fact that bovine tuberculosis is extremely rare in India, that the majority of children are breast-fed, that millions of people do not take milk, and those who do boil it before use, shows that consumption of milk is not an important cause of tuberculosis in that country. So that the broad and general factors—social, economic, industrial, and hygienic—that made for the increase of tuberculosis in the West have also affected the East with one or two additions: The tropical dust and heat; the debilitating effects of malaria and other fevers; the hopeless poverty of millions of the Indian poor, who are underfed and overworked; the joint family system,

* The present census is 319 millions.

which means living in crowded and insanitary houses; the purdah system, which secludes women in ill-lighted and ill-ventilated parts of the house; the custom of early marriage, which undermines the vitality of millions of youths and maidens (the latter of whom often succumb to tuberculosis after childbirth); and indiscriminate spitting—all have aggravated the bad conditions and considerably helped to spread the disease.[21]

The Psychology of Tuberculosis.—This brings us to consider the psychological aspect of tuberculosis, and to note that severe epidemics can also be brought about by the contagious power of emotion. Nash[22] observes that epidemics occur in times of great national emotion. As Le Bon expresses it: "Ideas, sentiments, emotions, and beliefs, possess in crowds a contagious power as intense as that of microbes." Such a recognition opens another chapter in the etiology of disease process. It is well known that violent mental emotions are followed by symptoms similar to those that occur in zymotic fevers. The writer has seen cases of cholera and bubonic plague occurring through sheer fright or nervous fear, and others have noticed that outbreaks of smallpox, measles, erysipelas, hydrophobia, etc.,[23] have been propagated from grave nervous apprehension. The recognition of psycho-therapy as a branch of medical therapeutics has brought home the importance of the mind factor in helping to cause functional and organic conditions. The various manifestations, such as psycho-neuroses, shell-shock, and other psychic disturbances following the horrors of the great war, have further drawn our attention to the interaction of the mind on the body, and the body on the mind. Many of the war neuroses, which appear to be purely functional, are really in a large measure due to organic lesions. Emotional reactions affect the mental state which influences the various organs and the vascular apparatus as shown by the inhibition of salivary and other secretions, rapid action of the heart, etc.

The new psychology teaches us that the physical energy that is derived from the nutrition of food and air acts on the lower

plane, and that the real power that gives the driving force to our lives comes from the higher energies acting on the psychic plane, and that the body nutrition is only intended to keep the various organs and tissues in a healthy state so that those energies may freely flow through our beings.

The increased demand for strength and power required to face the complex duties of civilization has no doubt placed a great strain on man's nervous system, and the more unnatural life he lives the greater the strain on his nervous and psychic mechanism. And constant effort to suppress the natural instincts and emotions tends to bring about an inner conflict between the instincts and the will or between the instincts themselves which, especially in weak natures, lead to mental exhaustion and various psychic and pathological conditions. The new psychology[24] further explains that in this mental conflict the mind is exhausted before the body, and that the most paralyzing of all emotions is fear, which was one of the most potent factors in the causation of war neuroses, and which has generally a depressing, paralyzing, exhausting, and inhibiting effect on body. and mind.

Deficiency of vitamines and other food accessory factors may produce degenerative changes in nerves, as polyneuritis in beri-beri. Many of the children's nervous complaints may be probably traced directly or indirectly to improper and vitamine deficiency foods. But strong emotions like fear may affect the nervous system directly, causing inhibition of gastric and other digestive functions. Nature has endowed the nervous system with such wonderful resisting and recuperative powers that it is not easily deranged or impaired. But the strenuous modern life entails constant anxiety and fear—fear of poverty or sickness, fear of failure or unemployment, fear of fear and other fears—which if allowed to operate for any length of time, or aggravated by insanitary conditions, wrong living, etc., would tend to depress the mind, lower the functions of the bowels, of skin, kidneys, lungs, liver, heart, and stomach, causing retention of waste products, intestinal stasis, and a long train of other evils. Nervous worry has been recognized

to have the effect of impairing gastric and secretory functions and of bringing about alimentary toxæmia. The physical signs of fear, which are similar to those of shock, act through the splanchnic nerves, and tend to cause paralysis of the walls of the intestines, causing the absorption of toxins into the blood. Nursing women are said to produce toxic milk after an outburst of anger or fright, because their emotions give a wrong stimulus, so that the cell that secretes normal milk or normal enzyme secretes toxin instead, in the same way that the soldier who in times of peace helps in agricultural work, gathering the harvest, etc., does the opposite in times of war, and destroys, instead of gathering, the fruits of the earth, and kills instead of saving lives.

Psychology and Tuberculosis.—These considerations will prepare us to understand the relation that exists between emotional disturbance and tuberculosis as the following cases will show:

Mrs. B., strong, healthy girl when married, shortly after marriage lost her husband in the war under shocking conditions (he was blown to pieces by a bomb). Ever since she heard the news of his sudden death, she lost interest in life, her appetite failed, emaciation set in, cough and temperature appeared, and tuberculosis was diagnosed; when she came to our sanatorium she had attacks of vomiting and diarrhœa, which, though improved from time to time, never disappeared; she put on no weight, the temperature kept high, was in bed for three months, and as she made no improvement, but was getting steadily worse, she was sent home.

Mr. H., a young lieutenant in the artillery, was sent to the front in the late war. The terrible sights he witnessed—the mutilation of his comrades, the stench of the trenches, the prevalence of vermin, the deafening noise all round, etc.—seemed to have unnerved him; he was sent to the hospital several times for gastric trouble and rise of temperature, and a patch in the right lung was found after examination. The news of the death of his wife at home completely prostrated him; gastric symptoms became worse; came into our sanatorium with mischief in both lungs and severe

dyspepsia, greatly emaciated, and is under treatment with a poor prospect of complete recovery.

Such cases can be multiplied. In civil life a young woman admitted to the sanatorium gave a history of tuberculosis, which she said she developed soon after the shock after an extraction of some teeth; in another case the disease seems to have started after the shock of hearing the groaning of wounded men and seeing a mutilated body in the recent riots in Ireland. In all these cases one notices that pulmonary tuberculosis seems to appear after a great emotional disturbance, causing gastric symptoms, nutritional disturbance, loss of appetite, constipation or diarrhœa, intestinal toxæmia, as if the fear or shock had more or less inhibited the gastric functions. These cases may be latent tuberculosis that had developed active trouble as the result of mental shock, but recrudescence of an old disease does not necessarily mean activity of tubercle bacilli. These four cases were selected because they were perfectly strong and healthy before they were caught in the emotional storm and gave no history of exposure to infection. In fact, the writer is convinced that some of the officers and soldiers he had examined who developed tuberculosis during the war service were perfectly healthy men when they joined the Army, and could find no history of contact infection after they had enlisted. The close connection of tuberculosis with the insane can only be explained by the fact that in many cases the disease developed as the result of the fires of life burning low, causing diminished vital resistance, asthenia, impaired metabolism, and malnutrition. So that we must honestly face the fact that sudden or slow affection of the mind of the soldiers or the insane has induced pathological conditions which resulted in producing tuberculosis, without, as far as one could judge, having any history of either latent or contact infection, and that when tubercle bacilli presented themselves they appeared as part of the pathological manifestation and not as a cause provoking the disease.

Ethics and Tuberculosis.—The contagion of ideas affecting mass movements and mass phenomena like epidemics operates

not only on the physical plane, but also on the moral. The belief among early peoples that evil is contagious has given strength to the present popular idea that micro-organisms are evil because they are contagious. The teaching of the old theology that men are born in sin, and are the children of wrath, and deserve eternal punishment, finds an echo in the attitude of our moral code and medicine. While ethics says that evil is the cause of crime, medicine pronounces that micro-organisms are the cause of disease. In the treatment, while one would cure evil by prison and punishment, the other would treat disease by injecting more micro-organisms. But a change can already be perceived in both domains in their enlarged and sympathetic outlook. The doctrine of man's inherent evil nature, and the threat of eternal punishment, has not helped to produce nobler lives and nobler deeds, while prison and gallows have not diminished crime and reformed criminals. So we have come to see that the doctrine of evil and the treatment based on it is wrong and unjust to all the higher instincts and purposes of man. We have also slowly come to recognize that man has something of a divine nature, that death and hell are not the ruling principles of the universe, that there is latent goodness in every soul, that all human actions are good so far as they are natural, and that evil which is greatly the result of vicious surroundings can only be arrested or cured by improving man's physical and moral environment, and by stimulating all that is best and noblest in him. So theology and philanthropy are busy in ameliorating the social conditions of the people, and the introduction of more humane methods in the prison system, such as juvenile courts, the Borstal system in this country, and Sing Sing prison in New York, has helped to diminish crime and the number of criminals.

So the parallel runs between theology and medicine in their belief in the reign of evil in man and microbes, and medicine has to meet the same conflict between the old and the new ideas. We argue that micro-organisms are not born pathogenic to hurt man, because we believe that man

is not born to evil and to sin; that the evil of bacterial germs cannot be destroyed by injecting more germs, because we know that evil cannot be exorcised by evil. Thus the higher plane gives a clue to the lower. On the other hand, man is intended for a life of goodness and gladness in the same way that Nature has intended that man should lead a healthy and wholesome life, that sorrow and evil are a blight and an excrescence as disease is an accident and unnatural. The State is called upon to choose between punishing and penalizing, or humanizing and stimulating the good in the criminal, and so medicine will have to choose between injections of more micro-organisms or improving the resisting powers of the tuberculosis patient. Just as the success of the reformed methods in the treatment of criminals shows that crime is mostly the product of vicious environment, so the success of open-air measures indicates that tuberculosis is very much a disease of lowered nutrition and unhealthy surroundings.

REFERENCES.

[1] Organism and Environment, by Haldane.

[2] 'A Brief Review of Bacterial Research in Phytopathology,' by M. C. Potter, *Science Progress*, October, 1919.

[3], [4] Report of the County Medical Officer of Health and School Medical Officer for the Year 1919.

[5] Semmelweis: His Life and His Doctrine, by Sir William Sinclair, p. 312.

[6] Proceedings of the Royal Society of Medicine, May, 1918, Section of Epidemiology and State Medicine, p. 113.

[7] *Ibid.*, p. 130.

[8] 'Sydenham as an Epidemiologist,' Proceedings of Royal Society of Medicine, July, 1919, p. 58.

[9] Evolution and Disease by Nash.

[10] Professor Schick, *Modern Medicine*, December, 1920.

[11] J. Brownlee, 'An Investigation into the Epidemiology of Phthisis in Great Britain and Ireland,' part iii., Medical Research Committee, 1920.

[12] Ewart, *Journal of Hygiene*, 1916, and *Brit. Med. Journal*, March 27, 1920, p. 444.

[13] Supplement to the Thirty-Fifth Annual Report of the Local Government Board, p. 94.

[14] 'Christiania and Norway,' *Lancet*, March 27, 1920, p. 730.

[15] The Influence of Strong, Prevalent, Rain-Bearing Winds on the Prevalence of Phthisis, by William Gordon.

[16] Hamer, same as references [3] and [4], p. 13.

[17] Samoans, Epidemiology of Tuberculosis, by George E. Bushnell.

[18] *Indian Medical Gazette*, 1912.

[19] Tuberculosis in India, by Lankester.

[20] Report on Malaria in Bengal, by Dr. Charles A. Bentley, 1916.

[21] Tuberculosis in India: Its Bearing on To-day's Problems, by C Muthu.

[22] Evolution and Disease, by Nash.

[23] *Ibid.*, and Hypnotism and Suggestion, by C. Lloyd Tuckey, p. 21.

[24] 'The Psychology of Power' (in God and His Relations to Man), by A. J. Hadfield (Macmillan and Co., London).

CHAPTER XI

HEREDITARY AND OTHER PREDISPOSING FACTORS

'The past still travels from afar,
And what we have been makes us what we are.
From the East.

'Our acts our Angels are, or good or ill,
Our fatal shadows that walk by us still.'
JOHN FLETCHER.

LEAVING aside the bacteriological, biochemical, and biological factors of tuberculosis, we proceed to examine the social, the economic, and constitutional factors, to see if their true value can be assessed and a right perspective formed in the etiology of the disease.

Environmental Factors.

1. Climate, Soil, and Occupation.—Still, humid conditions of the atmosphere are said to favour respiratory disease, including phthisis. The health of the body seems to depend upon the skin and the body reaction to atmospheric, climatic, and soil environment. The action of climate on tissue change depends upon its heat abstracting power, which in turn depends upon the temperature and the humidity of the air. If the air is charged with watery vapour, the body finds difficulty in getting rid of the heat as it is developed, and there is in consequence an indisposition to muscular and nervous action entailing lassitude and lack of energy. If exposure to strong winds has any relation to the prevalence of tuberculosis, as Dr. Gordon[1] affirms, it may be due to the moist conditions of the atmosphere rather than to the strong movement of the wind. We find that our patients are affected by warm, humid conditions of the atmosphere rather

than by the dry, bracing wind, except the north or north-easterly wind, and even these winds do not seem to affect them if they have made considerable progress in their health. Dr. Huggard,[2] from his experience of Swiss Alpine Resorts, finds that high altitudes with their low absolute humidity do not favour the prevalence of tuberculosis, and that the higher the altitude the less its prevalence, and *vice versa,* though the winds are more likely to prevail in the higher than in the lower altitudes. Brownlee[3] shows that the southern half of Pembrokeshire in Wales has very much less phthisis than the northern half, though the exposure to wind is much the same in both parts, and that though the winds sweep over Bala Lake so strong as to flood the holms at the northern end, yet there is little phthisis in Bala.

Soil.—It is found that phthisis is more prevalent among populations living on heavy, impermeable, and low-lying soils, which remain damp, than on light, porous, well-drained, and elevated soils, and that in those towns which show much drying of the subsoil as the result of drainage operations the death-rate from phthisis had decreased enormously. For instance, in Salisbury and Ely[4] the death-rate from this cause had diminished by 49 and 47 per cent. respectively, and in places where there was no fall of the death-rate there had arisen some other factors which had interfered. The investigations of Sir George Buchanan[5] in England and Dr. Bowditch[6] in America have also shown that dampness of the soil predisposes to tuberculosis. Dr. Nash[7] thinks that the tubercle bacillus or streptothrix could be traced to a common mould. Whatever connection a mould has to tubercle bacillus, it is undoubtedly related to damp walls and phthisis, since its presence is an indication of dampness in houses which, as Jaeger[8] says, diminishes the constitutional strength of their occupants by interfering with the exhalation of moisture by the skin and the lungs. If 'critical perspiration' (withdrawal of water) is a sign of returning health, interference with the evaporation of moisture and exhalations from the skin and mucous membrane would favour disease.

Both the humidity of the atmosphere and the moisture of

the soil tend to give rise to a catarrhal state of the respiratory mucous membrane, but whether such a congestive state could give rise to phthisis by favouring the growth of micro-organisms is open to question. We have already seen that inflammations are a physiological process, and congestions are efforts on the part of the organism to defend itself and to limit the assault of any micro-organism, and therefore inflamed tissues are not especially favourable soil for bacterial invasion—they are the very reverse, they are points of unusual resistance.[9] If, therefore, the dampness of soil and climate are associated with the growth of phthisis, it is more likely due to their effect on body metabolism and the nervous system. The humidity would increase the difficulty of getting rid of surplus heat, and would retard all vital, chemical, and electrical action in the body, and thus interfere with healthy metabolism. Brownlee[10] finds in Wales a close interrelation between the amount of phthisis and the nature of the geological formation, but, as he says, the geological formation comes in as a factor only in so far as it influences the social conditions of the people. Those parts of Wales, such as Cardigan, Carmarthen, and Haverfordwest, which are geologically disposed to phthisis, are places whose houses are damp on account of the nature of the rock of which they are built, where there is much poverty, the people live hard lives, whose diet is unsatisfactory, or who rarely eat fresh meat; but in places like Pembrokeshire, Radnor, Merioneth, and Montgomery, where the soil is rich and fertile, the people have a high standard of living and feed well, and are prosperous, there is very little tuberculosis.

Occupation.—Occupation involving the inhalation of hard particles of dust, as among tin and gold-miners, grinders, etc., seems to predispose to lung disease. Dr. Tatham[11] has shown that the death-rate from phthisis among potters, lead-miners, cutlers, and file-makers, was three and four times that of agricultural labourers, and among tin-miners five times as great. The coal-miners are remarkably free from tuberculosis of the lungs. The coal dust seems to stimulate the lining cells of the respiratory passages, which purify the lungs

by their phagocytic action. Even the dust, composed of silica and iron, as Professor Leonard Hill has pointed out, is only harmful when inhaled for a long period and in highly concentrated doses, which produce among the workers in flint, ganister, granite, and quartz fibroid phthisis much more frequently than pulmonary tuberculosis. The irritation caused by mineral or metallic particles, if long continued, would inflame and damage the alveolar tissue, reduce oxidation and interfere with healthy metabolism. The fact that the wives of tin-miners and grit-stone workers do not get tuberculosis, though their husbands occupy the same room and expectorate sputum loaded with tubercle bacilli,[12] shows that the tubercle virus does not take a prominent part in the spread of the disease among the mining household. If printers and compositors suffer from tuberculosis, it is not because they inhale the silica dust, as those who use the public roads and the road sweepers who inhale clouds of granite dust never seem to get silicosis in their lungs; it is because their occupation involves working in confined places, in stagnant overheated atmosphere, and in artificially-lit places which lower their metabolism and the vitality of the body. If occupation is studied from the point of view of wages, it would bring out more clearly its relationship to the morbidity of the disease. It would then be seen that the largest death-rate from tuberculosis (except those whose unhealthy occupation involves a mechanical irritation of the lungs and acute forms of fibrosis) falls upon the group of workers who are among the most poorly paid, such as labourers (except agricultural labourers), book-keepers, clerks, dress-makers, garment workers, female textile workers, cabinet workers, upholsterers, hair-dressers, etc., and the lowest death-rate falls upon the decidedly well-paid occupation groups, headed by bankers, Government officials, manufacturers, farmers, physicians, clergymen, and lawyers.

2. **Insanitary and Unhygienic Conditions, Overcrowding.**—Dr. Farr was the first to establish the association of increased morbidity and mortality with overcrowding. In Edinburgh,[13] when certain insanitary areas were replaced by

new dwellings which were provided with plenty of air and light and sunshine, the general death-rate fell from 45 to 15 per 1,000, and the phthisis rate from 3·8 to 0·4. So in Liverpool,[14] when the death-rate of tuberculosis was 4 per 1,000, in the new healthy areas with practically the same population it fell to 1·9. The relation to overcrowding can be seen in the industrial cities of every civilized State.

That in London the death-rate from consumption is directly associated with overcrowding, as pointed out by Sir Shirley Murphy, is seen by the following table[15] (based on two persons living per room in five-room tenements:

LONDON, 1901-1909.

PHTHISIS DEATH-RATE IN RELATION TO OVERCROWDING.

Proportion of Overcrowding in Each Group of Sanitary Areas.	Crude Phthisis Death Rate per 1,000 Persons Living.	Standard Death-Rate.	Factor for Correction for Age and Sex Distribution.	Corrected Death-Rate per 1,000 Persons Living.	Corrected Death-Rate (London) per 1,000.
Under 7·5 per cent.	1·034	1·718	1·00991	1·0444	709
7·5 to 12·5 „	1·320	1·705	1·01761	1·343	912
12·5 to 20·0 „	1·413	1·771	0·97969	1·385	941
20·0 to 27·5 „	1·924	1·805	0·96124	1·850	1,256
Over 27·5 „	1·953	1·651	1·05090	2·052	1,394
London	1·472	1·735	1·00000	1·472	1,000

From which we see that while the death-rate for phthisis in London was 1·044 when overcrowding was under 7·5 per cent., it reached 2·052 when there was 27·5 or more overcrowding.

In Glasgow:

Size of Houses	Death-Rate of all Ages	Phthisis Death-Rate of all Ages for Males.
One apartment	23·3	1·69
Two apartments	18·9	1·30
Three „	14·3	0·94
Four „	12·7	0·77

From Medical Research Committee's Report, No. 48, Part 3.

So that it is clear that the death-rate of phthisis increases on the whole with the density of the population. However, if we look into the matter a little more carefully, we shall find, as in the first group of factors, that here also insanitation and overcrowding are related to social conditions. The poor crowd together in slums and insanitary areas because of their limited means and poverty. That the ill-effects of congestion and bad hygienic conditions are due to attendant poverty conditions is brought out by many facts. Brownlee has shown that among the 'adult type' the phthisis death-rate in the London boroughs was not positively correlated, because we think that the good earning capacity of the adults has neutralized the evils of overcrowding. It has been our own experience among the London working-classes that as long as they had employment and good wages they suffered very little from phthisis in spite of their living in bad insanitary conditions. B. S. Warren,[16] studying the life of the workers in the United States Government printing and engraving plants, says that, despite the fact they are badly crowded and ill-ventilated, the mortality of the workers from tuberculosis is very low, because, he says, they receive good wages. Similarly he finds a disparity between the number of male deaths from tuberculosis (14·7 per cent.) as reported by the Censor Bureau, 1909, when compared to deaths among females (20·9) owing to the inadequate wages paid to women workers. So that overcrowding and insanitation operate as factors of tuberculosis only so far as they are the index to poverty and destitution.

3. **Poverty, Unemployment, Low Wages, Alcohol.**—Pulmonary tuberculosis claims its victims mainly from the poorly fed, poorly clothed, and badly housed members of a community. B. S. Warren, in common with many other observers, finds that low wages go hand in hand with high tuberculosis mortality. We have already seen that the death-rate from consumption varies according to the social position of the people of the country, falling most lightly upon the highest and wealthiest classes, and most heavily upon the lowest and the poorest. Every big city, such as

London, Paris, New York, tells the same tale—that the districts occupied by the rich and the well-to-do classes show an exceedingly low death-rate, while those inhabited by artisans, labourers, and the poor are thickly studded with cases of tuberculosis.[17] Comparing the mortality from phthisis in the most congested and poor parts of London with the healthy and rich parts, we find that Finsbury claims more than three times the number of deaths as Hampstead.

Death-rates for all ages and both sexes for phthisis in London boroughs, 1907 to 1911 (Medical Research Committee's Report, No. 48, Part 3):

Finsbury ...	... 2·14	Kensington ...	... 0·92
Shoreditch ...	... 1·90	Wandsworth	... 0·88
Southwark ...	... 1·90	Lewisham ...	... 0·75
Bermondsey	... 1·85	Hampstead ...	... 0·63

In Edinburgh, as in Glasgow, Dundee (see Chapter X.), and London, the mortality from tuberculosis increases in proportion as the house accommodation becomes limited, being greater in families occupying one room than two rooms, greater in the two than in three rooms, greater in the three than in four rooms. In Edinburgh, Maxwell Williamson[18] found that 70 to 80 per cent. of cases of pulmonary tuberculosis occurred in houses of three rooms and under. Good wages or income mean good food, better house accommodation, better sanitary and healthful surroundings, the command of more amenities of life, less care and worry with regard to living, whereas poor wages or lack of income mean poor food and poor surroundings, constant anxiety to feed the family and make both ends meet. Deficient food supply involves deficiency both in quality and quantity of food taken. The poor mostly live on tea, margarine, and white bread, which have very little nutritive value. Besides, they largely partake of stale food, tinned, frozen, and cheap food, which are not only deficient in vitamines, but being cheap and stale are polluted and contaminated, containing toxins which poison the system and open the door to disease conditions. When the quality of food is impaired, its power of assimilation is also lowered, and both deficiency in quality and assimilative power lead to deficient nutrition.

All the three groups of factors we have been discussing are related to each other and to the nervous system. Only the poor care to live in exposed parts and damp districts and unhygienic conditions. Where there is poverty, there is overcrowding and insanitation. If hygiene promotes mental efficiency, dirt, slums, and overcrowding bring about mental depression and impaired metabolism, which in turn lead to impaired efficiency, greater unemployment and poverty, and alcohol joins the vicious circle to intensify the effects of poverty and overcrowding.

4. **Physical and Mental Fatigue, Overwork and Excess of all Kinds.**—Under civilized conditions man leads a strenuous life, working late and long hours, and exposing himself to physical and mental strain—all of which tend to lower his vitality and depress his metabolism. Many a tuberculous patient staying at different sanatoria at the present time has been brought to ill-health by working long hours during the stress of the great war. Civilization also creates poverty and plenty, and both tend to result in impaired efficiency. While poverty leads to deficient nutrition through lack of food and assimilation, wealth, by tempting with a larger quantity of food than can be assimilated by the system, brings about, as Leonard Hill[19] pointed out, bacterial decomposition, absorption of toxins, and food deficiency through destruction of essential food principles. Thus both classes suffer in the end from the effect of food deficiency, and alcohol comes as a sinister figure to stir up the fires of toxic formation and impaired metabolism. Hence the explanation that excess of all kinds—food, alcoholic, sexual and emotional excess—leads to tuberculosis. When sedentary life is added to over-indulgence in food and alcohol, you get the story of many a city man debilitated by a confined indoor life, poisoned by gastric disturbance and predisposed to tuberculous, or, if not, to some other diathesis—rheumatic, gouty, alcoholic, or cancerous diathesis.

5. **Nervous Anxiety, Shock, Accident, and Injury.**—Pulmonary tuberculosis is closely associated with mental strain and depression. While worry and anxiety incident to

civilized life slowly sap the vigour and impair the bodily activities, sudden shock or accident acts with a tremendous force on the nervous system, inhibiting and paralyzing almost all the functions of the body. The effects of injury or accident are partly due to shock—mild or serious according to the extent of the injury—which causes mental depression and reduces the vital powers of the organism. Many a case of pulmonary tuberculosis begins after a severe domestic grief, which acts like a slight continuous shock on the system. The writer has been greatly impressed with a number of acute forms of tuberculosis, brought on through war shock or accident, or sudden fright. The usual explanation that fright or accident has roused the activity of tubercle bacilli, which were lying latent in the body, is a rather pious presumption, and does not accord with the past history or the clinical facts of the case. Whatever be the explanation, this much we do know clinically, that consumption shows itself through some disturbance of the nervous system or the digestive organs in persons who never had a day's illness and were strong and healthy before they were unfortunately struck down by shock or fright. Because we are materialistic in thought, we cannot recognize that the contagion of fear can cause bodily disease, including tuberculosis, without the intervention of micro-organisms. We have known Indians, who from sheer mental depression sat down and died, because they did not want to live. There are more things happening within and without the body than come under the cognizance of bacteriology.

6. **Deranged Mental Conditions, Feeble-mindedness, Insanity.**—Tuberculosis as an effect of feeble-mindedness has been frequently observed. There is a close relationship between poor and improper nourishment and mental condition of children, and with proper nutrition their irritability and nervousness have been noticed to disappear. Mental defective conditions and tuberculosis in adults are related to each other in more ways than one. Both are produced by defective social conditions, and both have some stigmata of degeneration attached to them, and in both there is some

defective functioning of endocrine glands. There is a heavy incidence and mortality from tuberculosis among the insane. It is reckoned that of the total deaths in the Prussian asylums, 36·3 per cent. were from lung disease, of which 16 per cent. were due to pulmonary tuberculosis.[20] Clouston[21] states that two-thirds of the deaths among idiots result from tuberculosis. Rivers[22] reckons that 93 per cent. of Mongolian idiots at Earlswood die of tuberculosis. Cretinism and myxœdema are closely associated with thyroid insufficiency, which in turn leads to defective nutrition, lowered metabolism, and tuberculosis. The increase of phthisis among the insane during the late war time was attributed to a greater congestion in the asylums and greater contact with infection. But as Tylecote[23] points out, the insane tuberculous patient has very rarely any expectoration, and therefore sputum cannot be the source of infection; he attributes the increase in mortality to diminished resistances from poor food and rationed deficiency of fats, sugar, etc. Mott[24] observes that in one-half at least of cases of dementia præcox there is complete regressive atrophy of the testes, leading to diminished vital resistance and tuberculosis from which a vast majority of these cases die. Charles Mercier[25] draws attention to the great importance of diet in the causation of mental disease, and considers that cretinism and myxœdema are due to defects in certain constituents of the blood. He finds that mental disorders are often accompanied by a deficiency of meat or excess of fat, sugar, or starch, and reports cases of recovery or improvement when the diet was rectified. He rightly argues that articles of diet should influence the mental health no less profoundly than physical health. The very fact that a great majority of the insane come from the poorer classes shows the real connection between insanity, lowered nutrition (acquired or hereditary), and tuberculosis.

Tubercle Infection.—From the study of the above predisposing factors of tuberculosis, an unbiassed reader will not fail to notice that they all primarily affect the nervous system, nutrition, and metabolism. Nutritional deficiency, either

through the deficiency of endocrine glands or through the influence of the nervous system, leads to deranged metabolism, which in turn produces pathological changes and diseased tuberculous processes. Such observations are in accord with biochemical facts, already noticed, that abnormal physiological and chemical changes from deficiency of vitamine and other food accessory factors result in deficiency diseases, and any micro-organisms found in connection with them appear as the result of such pathological and chemical changes. Tuberculosis, whether in the poor or the well-to-do classes, is also a deficiency disease. Whether the deficiency be nervous, dietetic, biochemical, or nutritional, the predisposing factors lead to abnormal changes, which may become pathological and create tuberculous soil. This tuberculous soil manifests itself in various ways: In poor and abnormal condition of the blood, as anæmia, enlarged glands, small and feeble heart, epistaxis, early hæmoptysis; in changes of the skin, as icthyosis, lupus, etc.; in the weakened condition of the mucous membrane, as rhinitis, ozæna, ear discharges, adenoids; changes in bone and cartilage, as nasal and thoracic deformity, spinal deformity, dental deformity, rickets; in the nervous system, as mental weakness, feeble-mindedness, insanity. All these changes or predispositions are the result of constitutional diathesis or weakened vitality, and, as Rivers[26] truly says, by no stretch of imagination can they be said to be caused by tuberculo-toxæmia; this theory of bacillary-toxic origin seems to cover a multitude of awkward facts which cannot be explained away. Mott[27] observes that when a chronic disease like tuberculosis is associated with the arrest of spermatogenesis, it is not due to any toxin, but to undeveloped testes, which goes first, and is already undeveloped before the disease makes its appearance—which shows that low vitality precedes the advent of tuberculosis. It would be much more true to speak of deranged metabolic toxin than microbic toxin as the cause of tuberculosis. These constitutional changes are the result of poverty, malnutrition, vitamine deficiency, and weakened constitution. And tubercle bacilli also appear as the result of such a soil. Without a

tuberculous soil the tubercle bacillus can have no power to grow or develop in the human body. We cannot strictly make a distinction between the seed and soil, between the exciting and predisposing causes as regards tuberculosis. What is predisposing may become an exciting cause, and what we call an exciting cause may also be a predisposing cause. Clinical experience corroborates both historical and biochemical facts in that in pretuberculous and early stages of tuberculosis no tubercle bacilli can be demonstrated. Patients kept under observation from the very earliest stages show no tubercle bacilli, and as the disease develops they may make their appearance slowly and gradually. In one case pneumococci were seen persistently for many months before tubercle bacilli made their appearance in the expectoration, and if the disease does not develop there may be no bacilli present at all. Such cases are called abortive tuberculosis by Bard and Fishberg. All this proves that tubercle bacilli are the expression of a tuberculous soil. How they arrive, and what part they play, we must leave to discuss in the next chapter. Meanwhile we may conclude that tubercle bacilli do not create a tuberculous soil, but appear as the result of it.

Environment and Heredity.—So far we have been considering environmental factors in relation to the etiology of tuberculosis. But environment alone is not sufficient to explain all that pertains to tuberculosis. Environment affects the soil, and the soil goes to form a diathesis of predisposition through some 'inborn errors of metabolism,' to use the classic phrase of Sir Archibald Garrod. And if the metabolic errors, due to lack of some intracellular ferments, or to some other biochemical deficiency or excess, persist in the blood, the predisposition goes further to form heredity.

In the lowest and simplest organisms, such as the unicellular asexual bacteria, we have the evidence of the influence of environment and evolution of heredity presenting themselves without any complicating factor. As we have already seen, alteration in the environment of bacteria, such as temperature, culture media, air and sunlight, etc., is quite sufficient

to bring about a modification in their form and growth, virulence, pathogenicity, etc., the variations impressing themselves in successive races and generations. But the factor of mind steps in in the case of higher organisms, and as it develops, its influence is more and more felt as we ascend the scale of organic life, till in man, in whom the mind is brought to the highest point of development, we have to reckon with a third factor—consciousness and personality—in dealing with his complex activities and with his health and disease processes.

As environment persists and develops, it makes for inheritance. Here we must avoid the errors of the two extreme parties—those who deny the facts of heredity, and those who explain that like produces the like. Heredity is a fact which cannot be gainsaid or controverted. The remarkable preservation of species of animals for hundreds of years, the physical and mental characteristics of families, races, and nations, the various predispositions to such conditions as gout, rheumatism, tuberculosis, syphilis, etc., testify to the part that inheritance plays in the life of lower and higher organisms. On the other hand, while each offspring inherits some qualities from its parents, it also adds some elements of its own, and both combining somewhere in Nature's laboratory give it a new individuality, so that it can be called a new creature.[28]

Acquired and Hereditary Characters.—The question of the relation between acquired and hereditary characters is not so formidable as it seems at the outset. It is known that germinal qualities can be influenced by conditions of nurture. If, then, an external stimulus can provoke germinal variation, it must influence the germ plasm, especially if the stimulus is persistent. It is not possible to draw a hard-and-fast line between exogenous and endogenous, between somatic and germinal, between acquired and hereditary characters. Dame Nature does not work in water-tight compartments. Nurture to-day may become nature to-morrow, provided there is no other influence to intervene. Heredity is not a fixed quantity that is unmoved by outside

influence, but, like life itself, varies, its variation depending upon external environment. Nurture, if persistent, can change the physical and mental characters of nature. The operation of persistent environment, such as nutrition, climate, education, etc., must in the long run lead to a variation in the germ cell. Alcohol, lead and other intoxications, gout, rheumatic and other diathetic conditions, the disturbance in the secretion of endocrine glands, are all capable of affecting the parental germ plasm and thus influence the offspring. So that it is not difficult to understand that 'conditions acquired by the parents reproduce themselves in, and become inherited by, the offspring."[29] The question of transmission or heredity depends upon the strength of environment. Non-inheritance of a quality is not to be interpreted as being exogenous or somatic, for some other and stronger influence may have neutralized or counteracted its operation, or it may be lying latent to become active in another generation. The effects of environment may not be seen for a long time, or may be eclipsed by some other influence, such as personality. Acquired characters, such as poverty, alcohol, etc., may not be inherited in the first generation, but if persistent in more than one generation must affect the germ cells and cause hereditary changes. So that the whole question of heredity depends upon whether the intensity or persistence of environment has caused the toxin or the poison of the parent to saturate the system so as to affect the germ cells. An intense environment leads to predisposition, and an intense predisposition will in time bring about heredity.

Therefore the difference between acquired and inborn characters is one of degree rather than of kind. If the predisposition is intense it must affect the germ cells whether in one or more generations; if slight, it may not become hereditary, but all hereditary qualities must have once (in previous generations) been acquired. In this way we can reconcile the attitude of both the Mendelians and Darwinians. The germ cell does not stand so imperially isolated as the Mendelians affirm. If the changes in the parent organism

can influence the germ cell—it is known they do—the acquired characters must be capable of hereditary transmission. When there is persistent environment or adaptation the functional changes go on to structural characters, which in turn lead to heredity. But man is not a slave of heredity. He is greater than his environment, because a third factor, which we shall presently consider, dominates both environment and heredity. The development of mind to the point of consciousness has not only separated him from the lower organisms, but has placed him in a higher category as well, and has made his inheritance, instead of being a mechanical thing, into something belonging to a higher plane.

Environment, Heredity, and Personality.—Environment and heredity alone cannot explain all the phenomena of human activities. There is a third factor—a dynamic force which the scientists have ignored, but which bridges the hitherto unexplained gaps seen in the biological study of man. Both those who believe that man is a product of environment and education, and those who think that heredity is everything, forget that personality exerts a profound influence over environment and heredity. Human personality is not absolutely determined by the parental germ cells, but stands on a higher plane, is intangible, and resides in the soil as the fragrance of a rose permeates the flower. It gives power to the will, gathers its own environment, shapes heredity, and linked with the higher energies, such as the instinctive emotions (fear, reverence, affection, love, faith, confidence), becomes the unknown factor which must be reckoned with in all our calculations of biochemical, biological, and psychological phenomena in the human organism. In fact, it is the driving force of life which distinguishes man from man, woman from woman. Personality coming in the domain of environment and heredity can correct their evil or stimulate their good effects just as Nature holds the fine balance of a salt like sodium chloride in the blood, by withholding it from being secreted if it is scanty or passing it freely in the urine if abundant. If personality is weak, the evil effects of environment and

heredity can overwhelm the human being; if it is strong, it can influence the soil so that even a vicious environment cannot cause infection; in the same way a man of strong character does not become bad by moving in bad company. Successive bad environment and heredity may go to weaken personality, and successive good personality may help to weaken the effects of bad environment and heredity, whereas the influence of a good environment may go a long way to strengthen a weak personality.

The strength of the predisposition to inheritance depends upon nutritional and other environmental factors and personality. These two working together can wash off a taint in successive generations by operating through the soil. Nurture and personality can inhibit the full expression of the undesirable elements in the herited nature. Heredity is more than a descent of qualities from parent to offspring. It includes variation, fluctuation, and mutation. When personality comes, the sphere of heredity becomes more complex. If a few elements are transmitted from one generation to another, there are other elements that make for variation, and personality makes for a still greater variation. One does not know whether personality alone can account for all the variations, or whether the living organism carries with it potentialities for variation. Where there is life there is diversity, elusiveness, and as we ascend the scale the operation of mind comes in as a third factor to take a prominent part, standing alone and still influencing environment and heredity.

It is here necessary to briefly examine the views of those who believe that tuberculosis in parents confers immunity to their children, and those who hold the opposite, that it makes them more susceptible to the disease. In support of the first, Carrière,[30] inoculating a series of male and female guinea-pigs with tuberculin, found, as a result, a heavy mortality in their offspring and a great number of still-births. Lustig,[31] by inoculating chickens, and Watson[32] guinea-pigs, with the phytotoxin, abrin, obtained in their offspring results of diminished fertility, and an increase in the number of still-births. Professor Stockard,[33] by subjecting male and female

guinea-pigs to the fumes of alcohol, obtained similar results of degeneration in their offspring—viz., a greater number of abortions and still-births, and demonstrated that under the influence of paternal alcoholism twenty-four matings only produced as many surviving young as might be expected from a single pairing of healthy guinea-pigs. In the case of workers exposed to the fumes of nitrate of mercury, Lizé[34] found a similar result—*i.e.*, a greater number of abortions and still-births than was at all normal. In support of the second view, clinical experience has shown that some children born of tubercular parents are not only stronger than their fathers and mothers, but escape consumption altogether. These two schools can be reconciled by the assumption that a higher law is also in operation than that working in the lower plane. In the cases of guinea-pigs the influence of conscious mind is more or less in abeyance, thus allowing the full effects of the environment. In workers exposed to the metallic fumes, the personality is, perhaps, weakened by a strong unhealthy environment, such as poverty, overcrowding, etc., and weakened constitution. But in the healthy children of tubercular parents their personality or dynamic energy was in full force which neutralized and conquered the evil influence of heredity.

Heredity is not only what is made for us through the ages, but also what we make ourselves through our own environment and personality. Inheritance does not altogether rest upon a physical basis. Man is more than his germ cells as he is more than microbes. It is possible that he, through the birth of consciousness and personality, and instinctive emotions such as faith and love, can acquire a new life, a new individuality, that is able to counteract the evil effects of the heredity, and thus take away the sting of despair and pessimism that clings round the fact of his inheritance. If it were not so, human life would be the most miserable, the most terrible of all existence in the universe. We ourselves have seen that under the Divine impulse, men and women have been 'born again,' the drunkard cured, the dissolute changed, the evil habits and

tendencies of a lifetime forsaken, and the seed of a new life implanted as if by a miracle. Nature alone can accomplish a great deal in this respect, by extinguishing a life full of taint, in the first instance, as seen in inherited syphilis, and neutralize the poison in successive generations till the stain is washed away. The Divine energy coming into human life can strengthen a weak personality, and repair the broken edifice of evil inheritance, and build a foundation of a new type, not by doing away with the evil effects of a bad heredity, but by overwhelming it in the same way that a man holding a stone in his hand does not destroy the force of gravity, but overpowers it by his higher energy.

Yet, in spite of all that has been said and written, we must confess we cannot attempt to dictate any final conclusions on the laws and operations of heredity. Man, being ultimately a spiritual being, is like 'the wind that bloweth where it listeth, and thou hearest the sound thereof, but canst not tell whence it cometh, and whither it goeth.'

Heredity and Tuberculosis.—These considerations will help us to understand the relation between heredity and tuberculosis. Bacteriologists, in their enthusiasm to prove the germ theory of disease, may be inclined to ignore all arguments that bear on inheritance. But heredity is too important a biological factor to be set aside in the etiology of tuberculosis. The researches of Pearson, Pearl,[35] and others bring out clearly the factor of heredity in the development of tuberculosis. Pearl studied the family histories of the blood relatives of 38 tuberculous and 19 non-tuberculous persons who numbered more than 5,000, distributed over five generations. He found that a tuberculous person has 7 per cent. of his or her blood relatives tuberculous, whereas a non-tuberculous person, chosen at random, has only 1·2 per cent. of his or her blood relatives tuberculous. We inherit for good or evil at least some of the qualities of our parents. For all practical purposes we may say that all constitutional diatheses affect the germ plasm and are therefore more or less hereditary. Micro-organisms have no place in heredity. Biologists cannot recognize that a microbe

can form a part of the organization of the germ-plasm,[36] so that what is inherited is not a specific disease, but a weakened constitution or will power, a lack of moral sense or control, an abnormal susceptibility or lowered vital resistance, a constitutional defect or diathesis. Here, again, whether the diathesis can develop into a disease in the offspring depends upon the strength of environment and personality.

Heredity is stronger than environment, in the same way that a rope made of many strands is stronger than a single strand. Just as the power of resisting attacks of yellow rust on wheat and mildew on barley is a heritable character, and that resisting plants breed true in this feature in the next and succeeding generations, so good heredity can counteract the effects of bad environment and resist tuberculosis. But if environment is atrociously bad, it may neutralize the effects of good heredity and provoke tuberculosis. A race is endowed with traits and characteristics that are inborn for many generations, so that generations of racial predisposition to tuberculosis may not be wiped off by good environment of a single generation. On the other hand, a strong racial heredity against tuberculosis need not provoke the disease even through a bad environment. This may be the reason that in the community at Framingham,[37] in America, it was found that the Italians living in the poorest district (of Framingham) and in the lowest hygienic condition had only about one-tenth as much tuberculosis as their more fortunately placed—hygienically and economically—Irish brethren. Here we see that bad environment is not sufficient to cause tuberculosis, and that a good environment is not enough to prevent the disease, because it seems that racial heredity is stronger than good or bad economic conditions. The Italian race stock had the lowest death-rate in spite of poor economic conditions, while one of the highest death-rates was found in the best residential section of Framingham community. Another explanation which is offered is that better economic conditions of the Irish had to be obtained by working harder and longer hours, and this overwork and anxiety entailed physical and mental strain

causing a greater incidence of tuberculosis, whereas the Italians were content to live humbly and cheaply, and had less nervous strain and less tuberculosis. Whatever be the explanation, it is certain that economic factors play a minor part when compared with hereditary factors which are cumulative in their effects in both individuals and races.

The history of mortality of the Jewish race from consumption offers another instance of the importance of inheritance in the etiology of phthisis. Feldman[38] says that statistics collected from different parts of the world go to show that, though the Jews are mostly town dwellers (four-fifths of the Jews live in cities), undersized, and narrow-chested, have been subject to ceaseless persecution and privation for many centuries, and largely engaged in indoor occupations, such as tailoring, bootmaking, etc., their mortality from tuberculosis is everywhere less than that of the people amongst whom they live, as seen in the following table:

MORTALITY OF JEWS (PER 10,000 POPULATION) FROM TUBERCULOSIS COMPARED WITH THAT OF OTHER NATIONS.

Place.	Period.	Jews.	Non-Jews.
Berlin	1905	9·8	21·6
Budapest	1905	21·9	46·0
Bucharest	1905	25·6	38·7
Cracow	1896–1900	20·5	66·4
Lemberg	1897–1902	30·6	63·5
London	1901–1906	13·3	17·9
New York	1906	13·5	23·9
Tunis (Algeria) ...	1894–1900	7·5	51·3
Vienna	1901–1903	13·1	24·6–38·8

The Jews are generally an abstemious race, and are more or less free from alcoholic and other vices. Another important factor that has contributed to their relative immunity is the sound foundation that is laid during their childhood. The Jewish mother suckles her children, and knows better than her Gentile neighbour how to feed them with good and nourishing food, and surround them with every care and attention in their tender years. There is no doubt that the devotion and solicitude in feeding and looking after them in

the days of childhood forms an important basis in rearing a healthy manhood and womanhood, and in helping to maintain the vigour and vitality of the race. If we compare the mortality of Jewish with non-Jewish infants in any city like London or Manchester, we shall find that, although both of them breathe the same air, the mortality among Gentile infants is in general about twice that among the Jewish infants, showing that hereditary and antenatal factors favourably influence the Jewish race.[39]

The strength of the family predisposition to tuberculosis is illustrated in the following cases taken from our sanatorium records. About ten years ago we had admitted into our sanatorium two sisters who, one after another, had fallen ill with pulmonary tuberculosis. The father was a builder in North London, the mother had hip disease, while a child suffered from enlarged glands and other signs of scrofula. They had three children—two girls and a boy. The parents were in easy circumstances, and brought up their children with every comfort. All the children were attacked with phthisis when they reached between nineteen and twenty-one years of age, while pursuing their studies at different places; and all of them commenced sanatorium treatment (the boy went to another sanatorium) as soon as the disease was diagnosed, and in spite of everything that was done they all died before they reached twenty-four. In another case, there were two brothers, both tall, and stood over six feet. Both of them were brought up exactly alike, both occupied the same bedroom, and both went to the same office to work, but one fell a victim to consumption at twenty-three in spite of sanatorium treatment, and the other escaped and is still keeping strong and well. The mother had died of pulmonary tuberculosis. Here are two among many instances where the family taint had helped to develop tuberculosis among the children who, in spite of good living and open-air treatment, died of the disease. In the second case, one of the brothers, perhaps, brought with him something besides hereditary qualities which was strong enough to overcome the predisposition to tuberculosis.

Though statistical evidence of heredity cannot altogether be relied upon, it may help us to form some general conclusions. Dr. C. J. B. Williams and Dr. Theodore Williams,[40] after investigating a thousand records of their private patients, found that 12 per cent. gave a history of 'direct hereditary predisposition' and 48 per cent. had family predisposition to tuberculosis. From our own sanatorium we gather that, out of a record of 1,014 patients admitted during the last twenty-two years, 33 per cent. gave a history of tuberculosis in the family, of which, in 10 per cent., one of the parents was affected, or died of tuberculosis. So that one cannot help agreeing with Professor Carl Pearson[41] that 'the diathesis of pulmonary tuberculosis is certainly inherited.'

Since tuberculosis is such a widespread disease in civilized countries, even in acquired tuberculosis there would very likely be a weak disposition which has been helped by a strong, bad environment, as poverty, insanitation, etc. Especially in children (as exemplified on a large scale in Germany, Austria, and other mid-European countries as the result of the war), in backward races and among lower classes in whom the mind is not fully developed or brought into full operation so that personality can assert itself, a strong adverse environment, as chronic starvation, chronic ill-feeding, malnutrition, etc., can provoke tuberculosis within a few weeks or months.

The serious part of the family taint or predisposition is that when it is strong it weakens will and personality, so that the offspring may suffer in two ways—by the strength of the poison, and by the weakening of its vital force and energy. Long ages of drink and poverty, bustle and excitement, toil and anxiety, must tell upon succeeding generations with greater and greater intensity, preparing the soil more and more for disease and degeneration. But we must not fall into the error of thinking that, because heredity is a factor to be reckoned with, it cannot be overcome by good environment—at least, so far as tuberculosis is concerned. Man is above heredity, and Nature can so work as to over-

come many obstacles, and convert the inherited weakness into strength, if she has something to work upon. If the open-air movement becomes more and more a power for good, in creating a healthy environment in the social and national life, the influence of heredity as a predisposing factor of tuberculosis would most likely become more and more weakened, especially if strong personality joins hands with good environment.

REFERENCES.

[1] The Influence of Strong, Prevalent, Rain-bearing Winds on the Prevalence of Phthisis, by William Gordon. London, 1910.

[2] Handbook of Climatic Treatment, by Huggard, p. 124.

[3] Brownlee, 'An Investigation into the Epidemiology of Phthisis in Great Britain and Ireland,' Part III., 1920, Medical Research Committee, No. 46.

[4] Supplement to Thirty-fifth Annual Report of Local Government Board, 1905-06, p. 98.

[5] Report of the Medical Officer of the Privy Council, London, 1866, p. 40.

[6] Consumption in New England, Boston, 1862.

[7] Evolution and Disease, by Nash.

[8] Problems of Nature, Researches and Discoveries, by Gustav Jaeger, p. 144.

[9] Inflammation — Defensive Mechanism, *Johns Hopkins Hospital Bulletin*, May, 1918, p. 107.

[10] Same as reference [3].

[11] Tatham, 'The Mortality of Males engaged in Certain Occupations in 1890-92,' Supplement to Fifty-fifth Annual Report of the Registrar-General, Part II.

[12] Pulmonary Tuberculosis, by Fishberg, p. 99.

[13] Transactions of National Association for Prevention of Consumption, 1914, p. 14.

[14] *Ibid.*, p. 61.

[15] Report of the Medical Officer of Health of County of London for 1909, p. 58.

[16] Pulmonary Tuberculosis, by Fishberg, p. 100.

[17], [18] *Ibid.*, p. 66.

[19] Report of Medical Research Committee, No. 32.

[20] Supplement to Thirty-fifth Annual Report of Local Government Board, 1905-06, p. 101.

[21] Allbutt's System of Medicine, vol. viii., p. 307.

[22] Three Clinical Studies, by W. C. Rivers, p. 166.

[23] *Lancet*, August 23, 1919, p. 348.

[24] *Brit. Med. Journal*, December 6, 1919, p. 742.

[25] *Lancet*, November 4, 1916, p. 630, and *Journal of Mental Science.*

[26] Three Clinical Studies, by W. C. Rivers.

[27] *Brit. Med. Journal*, November 29, 1919.

[28] Heredity and Environment, by Edwin G. Conklin.

[29] Medical Contributions to the Study of Evolution, by T. G. Adami, p. 69.

[30] Carrière, Medical Contributions to the Study of Evolution, by Adami, p. 62, and *Arch. de Méd. Expér.*, vol. xii., 1900, p. 782.

[31] *Centralblatt f. Pathologie*, vol. xv., 1904, pp. 210 and 756.

[32] *Brit. Med. Journ.*, 1905, vol. ii., 1091.

[33] Medical Contributions to the Study of Evolution, by Adami, p. 63.

[34] *Ibid.*, p. 62.

[35] 'The Relative Influence of the Constitutional Factor in the Etiology of Tuberculosis,' by R. Pearl, *Amer. Rev. of Tuberculosis*, 1920, vol. iv., p. 688.

[36] Heredity, by J. Arthur Thompson, p. 283.

[37] Modern Medicine, February, 1920.

[38] Feldman, 'Tuberculosis and the Jew,' *The Tuberculosis Year Book*, 1913-14, p. 48.

[39] Saleeby, Theosophist, April, 1920, p. 31.

[40] Pulmonary Consumption, by C. J. B. Williams and Theodore Williams. London, Second Edition, 1887, p. 62.

[41] 'First Study of Statistics of Pulmonary Tuberculosis,' *Brit. Med. Journ.*, August 3, 1907, p. 274.

CHAPTER XII

GENERAL CONCLUSION

'Yet I doubt not through the ages one increasing purpose runs,
And the thoughts of men are widened with the process of the suns.'
TENNYSON.

IN the foregoing chapters we have briefly examined the etiology of tuberculosis from many points of view and from many fields of thought, and we may now proceed to sum up our general impressions and conclusions. A careful survey of the whole question shows at the very outset that tuberculosis, in spite of widespread research and strenuous campaign against the disease, is still with us in as great a force as it was twenty years ago, and presents many problems that still remain unsolved. The knowledge that we know so little, that life is a mystery, and its unknown factors meet us at every turn, should tend to create a spirit of modesty and humility, which is a right attitude with which to approach the investigation of such questions as are connected with tuberculosis. The roots of disease seem to lie deep like the roots of a tree. Man is a complex being, composed as he is of visible and invisible elements, both of which go to make up his life, growth, and development, and hence his disease processes cannot be measured or valued by merely what can be seen or handled.

Bacteriology.—The germ theory of tuberculosis has rather increased than solved the problems that surround the causation of the disease. The principles on which bacteriology rests are—that at least as far as can be inferred from physiological and pathological experiments, the lower animals, such as rabbits and guinea-pigs, can be relied upon to yield results which can be equally applied to man; that disease is mainly caused by bacteria and their toxins; that pathogenic organ-

isms produce specific disease; and that natural and artificial infections are necessary for conferring immunity on man and animals. But we have seen that mutation of bacteria and the untenability of stability and specificity of micro-organisms have greatly weakened the position of bacteriology, that aerial infection cannot be maintained in many cases, that pathogenic bacteria have not been demonstrated in the atmosphere, and that Romer[1] was nearer the truth when he laid aside both the respiratory and the alimentary routes as channels of infection. If we do not know how tubercle bacilli get into the body, it is perhaps because in the majority of cases they do not enter from the outside at all, but are formed within the body. We have also seen that the results of artificial infection cannot be applied to ordinary life—as for instance, we can artificially infect the egg with tubercle bacilli, but in natural conditions fœtal infection does not generally take place in man or animals. The theories of contact and conjugal infection, of meat and milk infection, have proved unsatisfactory, and are opposed to clinical experience obtained on a large scale. The spread of tuberculosis through contact, conjugal, or epidemic sources, when it does occur, can be largely explained by the fact that groups of individuals similarly placed show similar symptoms and therefore produce similar disease. The association of a micro-organism in connection with a disease does not prove that it is the cause of it. Especially when that association is not constant, or when the disease is present in its absence, there is still more doubt as to its causal relation with the disease. Further, the application of the germ theory to explain the doctrine of immunity and the decrease of mortality rate among civilized people has rather confused than clarified the clinical problems. If the decrease of the mortality rate among civilized people be due to their exposure to tuberculous infection, why should those who live secluded lives, like nuns in a convent, prisoners in cells, and others who are most carefully shielded from opportunities of infection, get tuberculosis, while those exposed to infection, such as doctors, laryngologists, mothers and wives of consumptives,

have less tuberculosis if anything than others, and why should prisoners in solitary confinement be more subject to the disease than other prisoners? Baers,[2] an experienced prison physician, says that the frequency of phthisis among prisoners cannot be explained alone by direct infection. If prophylaxis against the disease is to be obtained by coming into contact with tubercle bacilli, and that immunity is conditional to exposure to tuberculous infection,[3] what is the sense of this vigorous campaign against the spread of tuberculosis? If tuberculosis immunizes the children, why legislate against tuberculous milk? If consumption is not infectious for those who have had tuberculosis, and if everyone, as Opie[4] has shown by radiograph, is tuberculous, what need is there for notification, segregation, and disinfection? Calmette[5] carried this doctrine to its logical length when he said that since tuberculous infection is necessary for the prophylaxis of tuberculosis, the eradication of tuberculous infection is not desirable. So that all measures taken against the arrest and prevention of the disease are wrong because they hinder the tuberculization of the people; and the Americans, Canadians, and Australians, who prevent consumptive emigrants from reaching their shores, to keep their countries free from tuberculous infection, are working against the interests of their country, as by their restrictive legislation they are preventing the tubercle bacilli from travelling abroad and tuberculizing their people. If consumption provides an immunity which prevents the race from perishing,[6] what is the meaning of the thousands upon thousands who still get the disease and die in civilized countries? If immunity has failed to tuberculize in such a large number of people, its efficacy in protecting the people against reinfection is very doubtful. To such confusion and contradiction are we led by the germ theory and its application to everyday life.

But the age of bacteriology is passing. We are beginning to see that man is profoundly different from the lower animals, that contact or contamination with micro-organisms can no more cause disease than contact with evil can make us evil, that acid-fast organisms can be present in tissues

without causing any clinical symptoms of tuberculosis in man or animals, that man creates conditions of pathogenicity for micro-organisms by his own vicious environment, and that immunity is a physiological and biochemical process residing in the cells and tissues of healthy individuals and is not dependent upon bacterial infection. The reign of microbes is due to man's fear and lack of knowledge—fear lest lurking in the air he breathes and the food he eats they would cause his destruction, and that in his attempt to kill them by boiling and sterilizing his food through lack of knowledge he destroys the very vital elements that make for his nutrition and life. The theory that the widespread prevalence of tuberculosis is caused by universal infection with tubercle bacilli is broken down in so many places that we shall have to construct a new line of thought that will satisfy the findings of modern thought and clinical experience. Here biochemistry comes to our help.

Biochemistry.—The marvellous strides made by physiological and pathological chemistry during recent years, and the far-reaching discoveries made in connection with endocrine glands and their secretions, have shifted the angle of vision from bacteriology to biochemistry and endocrinology which have revolutionized our ideas concerning the causation of disease processes—so much so that it is impossible to realize or foresee at present the full consequence of this research and revelation. They have shown that dietetic, endocrine, and vitamine deficiencies impair the nutrition of the body, and that the absence of vitamine essence in the food, and the presence of toxins from impaired metabolism consequent on such an absence, produce a pathological soil which is favourable to disease conditions, and the growth and virulence of micro-organisms. They also suggest that the number of affections, such as scurvy, beri-beri, pellagra, rickets, keratomalacia, myxœdema, and cretinism, which are already recognized as deficiency diseases, will have to be extended to diabetes, dysentery, cancer, leprosy, tuberculosis, anæmia, and still further to neuroses, cardiac affections, disorders of the skin and hair, of caries of

teeth, intestinal stasis, toxæmia, constipation, and many more vague and ill-pronounced disturbances of the nervous, circulatory, and digestive systems produced by improper food and faulty nutrition. The researches of biochemistry and endocrinology will help still further to see that functional and organic disorders are rather associated with some biochemical excess or deficiency than with bacterial infection, and that specific conditions of disease are due to specific metabolic disorders creating a variety—in number and intensity—of toxins rather than to specific organisms.

Side by side with the revelation that a large number of diseases are the outcome of nutritional, endocrine, and vitamine deficiencies, should be placed Nature's experiments made on a large scale on children and adults of Central Europe, which have shown that underfeeding and starvation, as the result of the Great War, have brought about a wholesale calamity of scurvy, rickets, and tuberculosis. On the other hand, clinical experience has shown that patients suffering from scrofula with sore eyes, enlarged glands, adenoids, and adult tuberculosis with emaciation, anæmia, cough, and fever, recover more or less completely under fresh air, food, and rest in the open air. All these factors justify us in claiming tuberculosis as a deficiency disease, a disease of malnutrition and lowered vitality, beginning at the tender years of childhood from improper and artificial feeding, and intensified by faulty economic and insanitary environment, especially during the periods of adolescence, middle and old ages—critical periods when endocrine glands with their activities more or less adjust themselves in their relation to one another. And any disturbance in their new adjustments, or any weakening of their system from other diseases, would still more intensify and precipitate a tuberculous condition which was lying dormant—thus accounting for Brownlee's classification of phthisis into adult, middle and old age periods. The universality of tuberculosis in civilized countries, and the phenomena of extensive tuberculous changes taking place silently in the lungs without interfering with the patient's health or his occupation, or showing any

clinical symptoms, go to prove that tuberculosis, at least in its early phase, cannot be called a disease in the ordinary accepted sense, and is more physiological than pathological. The absence of micro-organisms in many diseases, such as hydrophobia, measles, whooping cough, smallpox, etc., and sometimes even in tuberculosis, syphilis, malaria, influenza, etc., suggest that disease processes and symptoms are independent of the presence or absence of specific organisms, or if they are present, they may be in such a cyclical stage as to elude the microscope. Again, take another group of facts. There is no evidence that pathogenic tubercle bacilli under natural conditions get into the system through the respiratory or alimentary channels in the majority of cases, that infection is related to nutrition rather than to a bacterial organism which appears as the result of metabolic changes as seen in insufficiency diseases, and that tubercle organism and malarial parasite often appear long after clinical symptoms have manifested themselves. These facts give a clue that when tubercle bacilli appear on the scene, they do so as the effect of a cause, as the product of vicious environment; or if they have entered as a saprophyte (clinical experience shows that the majority of them do), their pathogenicity is the result of deranged nutrition. The time is soon coming when we shall see clearly, what we now see only dimly, that all pathogenic organisms are simply abnormal developments of saprophytes, which in the natural conditions are harmless and may even be beneficial to man.

This brings us to the crucial question, Whence and in what form do micro-organisms originate? What is their relation to the living cells of the body? The morphological or biochemical mutation of bacteria, as demonstrated by Hort, Twort, Penfold; the suggestion of Young,[7] of acid-fast bacilli arising from sporocysts, and her demonstration of the formation of cocci, etc., from bovine bacilli; the reproduction of tuberculosis from the injection of caseous material which contained no tubercle bacilli, as proved by Roux,[8] and gram-positive granules seen in caseous material, as demonstrated by Adami;[9] the presence of micrococci, or of streptococci and

staphylococci in the sputum of consumptive patients many months before the appearance of tubercle bacilli; and the fact that tubercle bacilli may be caused to enter the blood stream by tuberculin injection, or by the use of chemo-therapeutic preparations, as pointed out by Rabinowitsch,[10] all suggest that tubercle bacilli are not specific entities, but may arise from coccal forms, or from necrosis of tuberculous tissue as the result of tuberculin reaction or tuberculous process. Maher,[11] experimenting in his laboratory in America, has shown that when ordinary pathogenic human tubercle bacilli are grown in glycerine-broth potato for long periods, they acquire the power to grow at the room temperature, gradually lose their acid resistance and their bacillary form, and become coccoid and non-pathogenic and do not cause tuberculosis. All these observed facts, together with the presence of filter-passing, or ultra-microscopic germs, seen in connection with influenza, yellow fever, poliomyelitis, by many expert observers, compel us to infer that micro-organisms undergo a process of evolution in the healthy or altered juices of the body, and originate from still smaller bodies. Are these elusive minute bodies, as Adami[12] calls them, or scintillating corpuscles, as described by Pasteur, or globoid bodies found by Noguchi[13] in poliomyelitis, formed from some changes in the blood or tissue cells? Are the pseudo-parasites seen in malaria long before Laveran's bodies[14] make their appearance in malarial blood transformed blood corpuscles? Can the granules of protein described by Arkwright[15] in connection with influenza cases, or minute granules seen in Hodgkin's disease,[16] or the physiological units of Spencer, be traced to living, or degenerative, or ferment cells? J. B. Burke's[17] radiobes, found from chemical action of a catalytic nature, and Charles Bastian's experiments on histogenesis, foretold the evolution of germs from minute pre-existing life. As far back as 1875 Wilks and Moxon[18] reported having 'seen appearances that would indicate, but not quite certainly, that the bacteria in the products of inflammation, and to a less degree in the blood, arise from disintegration of white blood cells or of pus cells.' This was confirmed many years

later by C. H. Collings,[19] who, working in the laboratory of Clinical Research, demonstrated the gradual disintegration of leucocytes and pus cells into various stages, and at last into bacteria, as illustrated in the accompanying diagram (Fig. 11). These experimental findings throw a new light on the life-history of bacteria, which seem to arise from pre-existing cells. The researches of Young,[20] which have shown the development of a few dancing granules, seen in the serum taken from rheumatic subjects, into a further stage of bright and flocculent masses, which give rise to sporoblasts (nucleated bodies about the size of red corpuscles), which in turn form cocci and bacilli of various kinds, open up possibilities of the origin of micro-organisms from some altered condition of the blood. But it is not till we come to Béchamp,[21] professor of medical chemistry in the Montpelier University, France, and the contemporary of Pasteur, that our doubts are set aside, and many of the problems connected with bacterial evolution that puzzled the biologists and pathologists for years satisfactorily explained and solved.

According to Béchamp the cells of the body are composed of still smaller living elements known as microbes, or germs, which are made up of spores, or anatomical units, called microzymes, which are the ultimate atom, or the indestructible unit of life. These microzymes exist always in every part of every organism, and in every phase of its existence, and are an essential element of life, of disease, and of our bodily destruction. They are no more alien to the human organism than the liver or any other organ. They are living ferments, and accomplish the process of nutrition, and therefore fermentation is proved to be the phenomena of nutrition. If the machinery of the body is disturbed by some poison, cold, depression, physical injury, or shock, they become morbid microzymes, and, in their altered state of bacteria, carry on the benevolent work of destroying the organic matter on the death of the body, and when the destruction is complete, or when the diseased body returns to its normal health, they recover in the pure air their normal character of microzymes. Béchamp found that calcareous rocks yielded

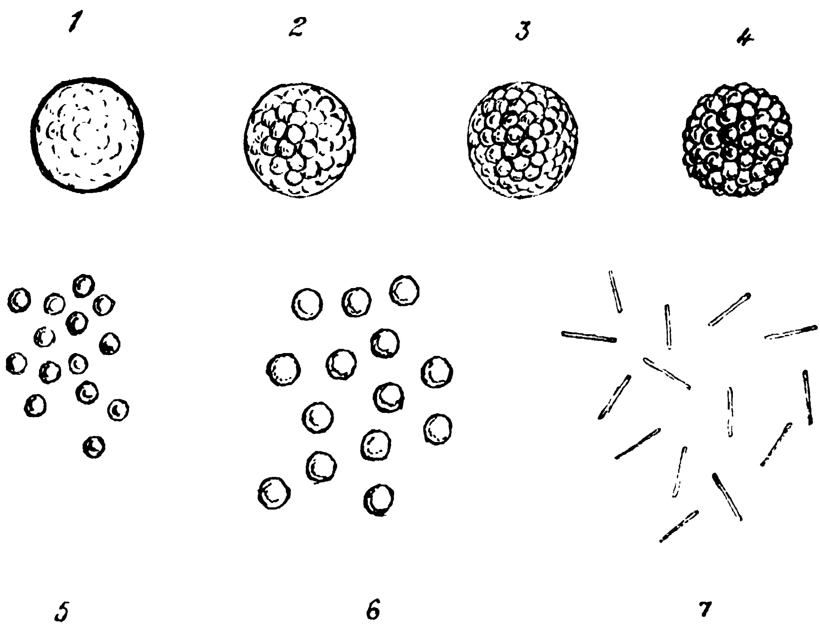

FIG. 11.—DISINTEGRATION OF LEUCOCYTES OR PUS CELLS AND THEIR TRANSFORMATION BY SUCCESSIVE STAGES INTO BACILLI.

1. Leucocytes breaking down. 2. Accentuation of spore bodies. 3. Spore bodies highly refractive. 4. No outer wall visible. 5. Separation of spore bodies. 6. Enlargement of spore bodies. 7. Their becoming bacilli.

(Reproduced by permission of C. H. Collings.)

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microzymes, the remains of life in the remote zoological past, which he proved by experiments to be living ferments. So that they are not only the living remnants of dead bodies, but are also parts of actual living bodies. He further taught that bacteria are simply microzymes in evolution and do not attack us from without, that disease mainly arises from ourselves and in ourselves,[22] and that bacteria are of our own manufacture and are but the morbid forms of the benevolent microzymes which are essential to our existence. So they are not the cause, but only the effect, of disease.[23] Such an explanation of the phenomena of the living organism reconciles many bacteriological, biochemical, and biological facts we have already considered, and explains many clinical observations, such as why micro-organisms are found both in health and disease, why pathogenic bacteria disappear when health returns after disease, etc. Also Béchamp's discovery years ago that microzymes, the unit of life, are living ferments, and that fermentation is nutrition, is in keeping with the findings of modern biochemistry, that cell life is more or less entirely a matter of enzymic activity. Further, Béchamp's teaching was anticipated by Pidoux, the friend of Trousseau, when he said that 'diseases are born of us and in us,' and Hippocrates, who, in his famous aphorism, spoke for all time—'*Quæ faciunt in homine sano actiones sanas, eadem in ægroto morbosas*' (The things which in the healthy man produce healthy and useful actions, in the sick noxious symptoms). All the pieces of suggestive evidence we have thus brought forward from various sources, when put together, give us the right to surmise:

1. That micro-organisms arise for the most part from within from the altered condition of the blood.

2. That this altered state of the blood has been brought about by a vicious environment—nutritional, metabolic, and hygienic—causing the saprophytes to take on pathogenic properties which make for disease processes.

3. That in turn these pathogenic organisms, by a more favourable environment, can become saprophytes and harmless, which coincides with a return of health.

4. That Béchamp explained these phenomena by pointing out that both tissue and blood cells on the one hand and microbes on the other are one and the same, only in altered forms brought on by man's changed environmental conditions.

Such a rational conclusion is surely more in keeping with the advanced knowledge of higher physiology, biochemistry, and biology than the present-day teaching of bacteriology.

Moreover, the doctrine that diseased conditions are within us bears a close analogy to the moral and philosophic idea that we carry within us potentialities for good or evil—a thought which the poet has beautifully rendered in the immortal verse:

> 'Our acts our Angels are, or good or ill
> Our fatal shadows that walk by us still.'

Biology.—After biochemistry has explained the process of metabolism and nutrition in relation to health and disease, biology takes us further and reveals the wonderful adaptation of Nature to changing conditions of environment. Metabolic variation gives rise to biologic variation in man and micro-organism. Life is maintained by a continuous adjustment to varying conditions of its surroundings. Nature is incessantly working to bring about an organic equilibrium and order. That 'My Father worketh hitherto, and I work' is a scientific truth. The more one contemplates Nature the more one is profoundly impressed with her numerous laboratories and workshops, her hundred and one activities, her army of enzymes and catalysts, her myriad chemical and oxidative processes, her constant efforts to regulate the delicate respiratory exchanges, and the exact chemical composition of the blood to maintain normal metabolism. These biological adjustments are carried on even in abnormal conditions. There is no frontier line between physiology and pathology which is really continuous with biology. Virchow was right when he said that disease does not differ in principle from life. The symptoms of disease are part of the healing process. Hyperæmia, inflammation, fever, various exudations and secretions, and even acidosis, may be more physiological than pathological

activities employed by Nature to restore health. Looked at in this way hyperæmia and early hæmoptysis have a healing purpose in pulmonary tuberculosis. Behind the formation of tubercle is the altered blood condition, the congestion of bloodvessels, the exudation, the formation of new tissue and the breaking down—to clear the body of everything detrimental to the system and bring about a cure or arrest of disease. Even micro-organisms in their biologic evolution seem to carry out the beneficent action of Nature. Whether we consider them as healthy or morbid living cellules of the body as Béchamp taught, or as saprophytes or pathogenic organisms, they help man in health and disease, just as in the moral world both good and evil have their part to play in building character. Behind all the apparent chaos and confusion in Nature's manifold activities there seems to exist a definite purpose, a foresight, a design to bring harmony and to restore order.

Psychology.—Behind microbes there is metabolism, and behind metabolism there is mind. So from biology we ascend to a still higher ground to see a wider range of reality in psychology. While biochemical and biological activities influence and are influenced by the sympathetic, the mental and the emotional part of man from a higher plane keeps watch over life's processes and cell metabolism through the nervous system. The influence of mind through the endocrine glands is a profound factor in the etiology and treatment of tuberculosis. All the predisposing factors we have considered may be enhanced or neutralized in their effects to produce tuberculosis by the psychic and other higher influences. Mental shock and depression can cause such abnormal changes in the body metabolism, that cases of consumption caused by some mental disturbance present a grave prognosis. On the other hand, man's dynamic energy and strong personality can neutralize any amount of toxins and ward off many an attack of disease. From psychology to such higher energies as faith, confidence, hope, and love, is only a step, and all the operations of the mind and spirit over the body, and vice versa, go to play their

part in making the constitution of man. The soil is more than food and drink, more than hormones and vitamines. It is a blend of body, mind, and spirit. Just as behind proteins and carbohydrates there linger the salts and unknown vitamines which give the finishing touch to nutrition, growth, and development, so behind the body there lie the influences of all the planes—the genius of the past, the glory of the present, the passionate yearnings and aspirations, the laughter and the tears, the hopes and the fears, the environment and the personality, the moral and the spiritual, the social and the industrial elements. All these go to make up the soil of man—Nature's sanctuary which she keeps guard over with jealous care, and works to the last to maintain its purity and healthfulness.

The parable of the sower is a scientific document. There one sees that while the seed sown is just the same on different grounds, the soil in which it has fallen is varied, which has made all the difference between sterility and fertility. So even granting that tubercle bacilli and tuberculosis stand in relation as seed and soil, the presence of tubercle bacilli does not produce tuberculosis because the soil governs the operations of the seed and nullifies its effects: so that the seed does not create the soil as the old school of contagionists affirms, but the soil gives rise to the development or the pathogenicity of the seed, which, therefore, is the consequence rather than the cause, the product rather than the producer of the morbid soil. Wherefore the tubercle bacillus is an expression of some disorder of metabolism and not the cause of it, in the same way that the presence of a physician in a house is an indication that there is sickness in the family, and not that he is the cause of that sickness.

In summing up the main causative factors of tuberculosis, we find that not only deficient food and vitamine conditions, but also excessive physical and mental strain can induce chemical changes which impair normal metabolism, and weaken the defensive powers of the body. Hence poverty and insanitation with their associated evils on the one hand,

mental stress and anxiety on the other, by causing faulty nutrition, become the chief factors of tuberculosis. How? Here there are three schools of thought to claim our attention. The orthodox believers in contagion affirm that the seed creates the soil,[24] and that tubercle bacilli cause impaired metabolism and tuberculosis. The more progressive among them, taking their clue from biochemical and biological findings, assert that disorders of nutrition bring about abnormal tissue conditions and render them susceptible to the invasion of tubercle bacilli from without. A still more advanced school believes with Béchamp that such abnormal metabolism gives rise to changes in the tissue cells, which themselves become morbid bacteria, and thus micro-organisms are the products of the body. Anyhow, all roads of etiology lead to deranged metabolism in tuberculosis, and if micro-organisms are the product of man's social environment as we have shown, poverty and underfeeding, worry and anxiety, social and economic considerations, far outweigh as causative factors the theory of bacillary infection. As for tuberculosis of cows, it can be explained that just as food factors induce tuberculosis in man, so prolonged and unnatural lactation, and poor fodder, and unhygienic environment have produced conditions of deficiency and tuberculosis in milch cows, and it is possible for the hand-reared infant to get the disease as the result of being fed on such innutritious milk. Tuberculosis in cows is therefore the expression of poor soil and poor nutrition rather than of infection. Both the calf and the infant begin life free from tuberculosis, and the older they grow in deficient and unhealthy environment the more likely will they be affected by tuberculosis.

Diathesis.—The soil would make for diathesis in the same or the following generation. The various dietetic, endocrinous, and vitamine deficiencies would create a variety of metabolic errors or abnormal conditions, and would group themselves in certain disorders or diatheses. Some metabolic disturbance, followed by a dyscrasic state of the blood, seems to be a common factor in tuberculosis, cancer, alcoholism, gout, rheumatism, etc. There seems to be some interrelation between various diatheses as there is an interrelation

between micro-organisms. It is well known that tuberculosis is associated with diabetes, alcohol, syphilis, etc., and that syphilis is an undoubted factor in cancer of the tongue. Many forms of tuberculosis, especially scrofula, develop most often in syphilitic soil, and Sergent asks whether it is not often the indirect result of inheritance of a syphilitic soil. Scrofulous families are specially liable to cancer, though not in the same generation. Creighton,[25] in his recent book, gives an instance of a scrofulous strain leading to cancer in four members of the same family; of another case where cancer of the stomach was preceded by chronic alcoholism. Also, he found the same thrombotic blocking of bloodvessels, epithelioids, and giant cells in many forms of cancer as in tubercle. Both in syphilis and tubercle there seems to be the same suprarenal, thyroid, and pituitary insufficiency.[26] In fact, Hertoghe[27] thinks that syphilitic, tuberculous, alcoholic, and malarial conditions or degeneracies, when traced to their ultimate cause, will be found to be the outcome of thyroid insufficiency, and thus an etiological unity may be seen among their morbid conditions through some endocrine deficiency. The difference in the diatheses would be influenced by the difference in the more or less extent of lesions in the endocrine organs, or in their want of adjustment with one another. And these differences, bringing about complex changes in the chemistry of the body, would produce a variety of metabolic disorders and pathological processes, which offer a better explanation of diathetic and diseased states than that of bacterial origin.

The Ultimate Triumph.—After diathesis comes heredity. The strength of heredity lies in the strength of diathesis. So tuberculosis can be traced to environment, soil, diathesis, heredity, and personality, and whatever be the factors man meets on the road, he speaks the last word in the causation of the disease. At birth he brings his tools with him to build his palace, and thereafter he works till the evening to finish his task. Environment cannot cripple him, heredity cannot master him. There is an inherent Law of Life which knows no defect or defeat. With a soil composed of nothing better than three-fourths of water and common salt it has produced

the eloquence of Demosthenes, the philosophy of Aristotle, the poetry of Shakespeare, the music of Beethoven, the art of Michael Angelo, the genius of Darwin, and so it will produce miracles throughout the way and come out triumphant. It may be soiled by diathesis and seared by crime; but suffering and tears will only ennoble it, the fall and stain will only purify it, if not in one generation, in subsequent generations.

> 'There shall never be one lost good! what was, shall live as before;
> The evil is null, is naught, is silence implying sound;
> What was good shall be good, with. for evil, so much good more;
> On the earth the broken arcs; in the heaven, a perfect round.'

We may not know all its ways, or follow all its intricate methods, but it is certain it will lure us to final victory over disease and crime, over time and death. True, meanwhile we are groping in the dark, we see truth only in hints and suggestions, in glimpses and metaphors, and the vision of absolute reality is beyond us. In spite of all that has been written, the problem of tuberculosis may remain a mystery and may need diligent search in the future. The charm of medicine has always been its endless quest after the unknown. But let it pronounce it has found the microbe or has discovered the cause, it will cover itself with falsehood. For throughout the ages the medicine man has been the mystery man, and 'the best is yet to be.'

But life becomes false when custom gets crystallized into a cut-and-dried method or a rule-of-thumb policy. Let medicine try to diagnose the presence of sýphilis by the Wassermann reaction, or of consumption by the presence of tubercle bacilli; let theology declare that when a set of prayers is read or hymns sung, there is religion; let law and morality pronounce that when a loaf of bread is stolen, there is crime irrespective of any consideration of the human factor such as hunger, etc.—there orthodoxy manifests itself to stifle truth. But as biology finds a place for periodical mutations to break the monotonous level of heredity, so the appearance of spurts and variations, of rebels and heretics, in medicine, theology, and morality, brings a breath of fresh air to blow away the cobwebs that

man weaves round to enslave truth, converting heterodoxy of to-day into orthodoxy of to-morrow. So evolution proceeds with the progress of knowledge, and truth ever marches onward widening the thoughts of men in every generation.

If the wider conception we have sketched in the foregoing chapters of disease processes of the rôle played by bacterial germs or by the living organism in maintaining health and restoring order be recognized, it would give a new interpretation of life, it would open a new era in medicine. It would enable medicine to stand on a higher ground than the material plane, and view the morbid world with a clearer view and truer perspective: it would alter its methods of treatment in conformity to Nature's ways and to the moral and social environment of man. It is because the open-air treatment has dimly followed the lines of the new interpretation that its success in the past can be explained and its promise of the future can be assured.

REFERENCES.

[1] Romer, Pulmonary Tuberculosis, by Fishberg, p. 37, 41.

[2], [3], [4], [5], [6] Epidemiology of Tuberculosis, by George E. Bushnell.

[7] 'Some Modifications of Common Bacteria,' by C. W. Young. Paper read at Annual Meeting, British Medical Association, July, 1914.

[8], [9], [12], [16] *Brit. Med. Journal*, October 14, 1916, p. 526.

[10] Transactions of National Association for Prevention of Tuberculosis, 1913, p. 48.

[11] Maher, 'How Tuberculosis Schemes fail and Why,' *Medical Record*, New York, December 11, 1920.

[13] *Modern Medicine*, February, 1920.

[14] *The Lancet*, February 28, 1920, p. 519.

[15] Arkwright, *Brit. Med. Journal*, August 23, 1919, p. 235.

[17] Burke's Radiobes, *The Lancet*, July 26, 1919, p. 175.

[18] Pathological Conditions, by Wilks and Moxon, 1875, p. 624.

[19] The Cause and Cure of Consumption, by Valentine Knaggs, p. 50.

[20] Young, *Brit. Med. Journal*, October 24, 1914, p. 710.

[21] Les Microzymes, by A. Béchamp. [22] *Ibid.*, p. 804.

[23] Comptes Rendus, t. lxvi., p. 863.

[24] Pulmonary Tuberculosis in General Practice, by Halliday Sutherland.

[25] Some Conclusions in Cancer, by Creighton.

[26] Hutinel, 'Syphilitic Dystrophies of Infants,' *Archives de Médecine des Enfants*, January, 1920.

[27] Hertoghe, 'Thyroid Insufficiency,' *The Practitioner*, January, 1915, p. 64.

CHAPTER XIII

SOME CLINICAL POINTS IN THE EARLY DIAGNOSIS, SYMPTOMS, AND PROGNOSIS OF PULMONARY TUBERCULOSIS

'There is a depth below the depth,
And a height above the height;
Our hearing is not hearing,
And our seeing is not sight.'

THE early diagnosis of pulmonary tuberculosis is one of the most important and responsible tasks that fall upon a physician, since upon his correct diagnosis and decision depend the future of many a precious life and many a promising career. The knowledge of the early symptoms and physical signs and their correct interpretation are beset with many difficulties which demand much patience and experience, foresight, and intuition before they can be successfully overcome. It is such a protean disease that we are not in agreement as to what an early stage of the disease means, or when it begins. It makes its appearance in a variety of ways, involving a variety of symptoms in different patients. It is often such a chronic affection that its beginning may be traced to childhood, followed by many exacerbations and intervals of quiescence, or it may present a widespread involvement of lungs without any corresponding symptoms, and even without the knowledge of the patient himself. Also, when it begins, its symptoms may not have the same significance in different patients. In some the diagnosis and prognosis may depend more upon their vital resistance than upon the extent of the lesion, or the presence or absence of symptoms and signs. It is only by taking into consideration all the available antecedent and clinical factors, and placing them according to their right value and perspective, that a

true picture of each case can be constructed and a correct diagnosis made.

At the beginning of the open-air movement the complaint was loudly made that patients were not diagnosed early enough to get the full benefit of the sanatorium treatment; but now the tendency is to cry out that refined methods of examination have brought into the sanatorium many non-tubercular cases. When is a case said to be tuberculous or non-tuberculous, and what are the symptoms and signs that go to decide a positive diagnosis? Here, again, the etiology of the disease that has been presented in the previous pages would help us in forming a more or less right decision.

The most important aids to early diagnosis in vogue at the present day are: Tuberculin reaction, X-ray examination, the presence of the tubercle bacillus, and physical symptoms and signs.

Tuberculin Reaction.—No reliance can be placed on the diagnostic value of tuberculin in adults or even in children. The positive reaction cannot indicate whether the lesion is active or of long-standing, nor can it give a decided certainty of the presence of the disease in otherwise doubtful cases. In a study of 460 children under seven years of age with tuberculin, 33·3 per cent. were found to be reactors. Two and a half years later, of these 150 reactors only one is known to have developed any form of tuberculous disease[1]—showing that even in children tuberculin reaction does not mean that there is any tuberculous disease, and that malnutrition alone can cause a positive reaction.

Again, as Wells[2] observes, beginning with the classical observation of Matthes that the tuberculin reaction could be produced with deutero-albumose, many similar non-specific reactions have been observed. Particularly the sharp reaction in typhoid patients, following intravenous injections of killed typhoid bacilli, has been found equally well if colon bacilli are used, or deutero-albumose. Dr. Addgren,[3] of Stockholm, states that tuberculous individuals often respond quickly to injections of milk by a local and general reaction. So that we cannot tell what a positive tuberculin reaction

signifies clinically. Besides there is a distinct element of danger of tuberculin lighting up an old focus or rousing into activity a latent tuberculosis. The writer has seen a focal reaction provoke an extension of the disease, hæmorrhage, high fever, which took months to subside; therefore he quite agrees with Sahli[4] that 'the use of tuberculin for diagnostic purposes ought to be condemned. It is unreliable, both positively and negatively. Diagnostic injections are dangerous.' Lydia Rabinowitsch[5] also warns us that through the diagnostic use of tuberculin virulent tubercle bacilli may be caused to enter the blood stream.

X-ray examination may show shadows, mottlings, and opacities at the apex, the hilus, and the roots of the lungs, indicating airless or fibrous tissue, but they are not pathognomonic of phthisis. These abnormalities have been equally observed in thickened pleura, healed tubercle, peribronchial thickening, enlarged and calcified glands, as well as in active tuberculosis. It does not enable us to distinguish an active mischief from an healed lesion. Besides, as Pottenger[6] observes, small early lesions may not always cast a shadow to be recognized in the X-ray plate, so that the skiagraph alone is of no value in the diagnosis of incipient cases or recent tuberculous infiltrations. It may be useful to verify well-marked pathological changes, and be of assistance when taken in conjunction with constitutional symptoms and physical signs; but if clinical examination fails, it cannot help in clearing up a doubtful diagnosis of early cases.

Tubercle bacilli do not appear in the very early stage of pulmonary tuberculosis. To wait for their presence in the sputum is to wait for the softening and breaking down of the tuberculous focus, which surely endangers the chances of early recovery of the patient. Further, the negative evidence does not indicate the absence of the disease. About a third of our patients at the Mendip Hills Sanatorium, who had clinical symptoms of phthisis, had either no sputum or sputum containing no tubercle bacilli. Klotz[7] says that medical reports of numerous tuberculosis sanatoria show an average of only 50 per cent. of cases, including all stages in

which tubercle bacilli are found in the sputum. Watson,[8] of Mount Regis Sanatorium, states that out of fifty-nine incipient cases admitted into that sanatorium only two showed positive sputum after repeated examinations. Even positive evidence does not mean that the patient is suffering from active tuberculosis. As already pointed out, ex-sanatorium patients who have returned to active work may bring up tubercle bacilli for a long time after they have left the institution. Again, Boston[9] found in patients suffering from acute colds and influenza acid-fast bacilli which disappear during convalescence. So the microscopical examination does not help us very much in the diagnosis of early incipient phthisis. No case can be called non-tuberculous from mere absence of tubercle bacilli, as in the great majority of early cases they are absent. Unless we recognize that phthisis can be present without tubercle bacilli we are sure to miss early cases or make a wrong diagnosis from negative evidence.

Physical Examination.—One or all of the above methods may help or fail the physician in forming his diagnosis. But the decision must come from him, based on the clinical symptoms and signs he has observed by the bedside. If he cultivates the faculty of hearing, the power of observation and the use of the stethoscope, he will be sure to detect the early presence of the disease without having to resort to outside evidence. The writer would emphasize, as he has already done many years ago in his former volume, that the physical examination of the lungs by the trained eye and ear of the physician gives important evidence which can be more or less relied upon in the early diagnosis of pulmonary tuberculosis.

Stigmata, Predisposition, etc.—Before the examination of the lungs the physician would get some information by going over the patient's antecedents. A history of rickets, of scrofula, enlarged glands, of hæmoptysis, pleurisy, or any family predisposition should be taken note of. A history of repeated attacks of colds, influenza, of domestic grief, shock, business worry, etc., would go to help in the diagnosis.

Ichthyosis is often associated with tuberculosis. All nasal defects, as Rivers[10] pointed out, septal deformity, chronic rhinitis, predispose to the development of tuberculosis. Congenital defects, like cardiac malformation, congenital idiocy (Mongolian type), hypothyroidism, or endocrine deficiencies, are relatively common in tuberculous subjects. Blue veins upon the anterior thoracic parietes, phthisical complexion, smooth skin, blue eyes, blonde hair, etc., and the phthisical chest of Hippocrates, which includes flat or pigeon chest and other deformities, betray a strong predisposition to tuberculosis. Charrin[11] describes malformations like polydactyly, spina bifida, hare lip, club foot as occurring noticeably in the descendants of tuberculous persons. All these abnormalities and degenerations are in the first place due to nutritional disturbance, which in course of time become the cause or the effect of the predisposition to tuberculosis.

Early Symptoms.—Pulmonary tuberculosis in the incipient stage presents a wide variety of types and symptoms. There may be at the beginning nothing more noticeable than a run-down feeling, general malaise, lassitude, a feeling of fatigue on comparatively slight exertion, which surprises the patient, and which he says he cannot account for, as he always felt well before. Or some gastric disturbance, anæmia, symptoms of chronic toxæmia from constipation or some intestinal stasis, languor, debility, loss of weight with increased pulse rate, and possibly a slight rise of temperature, are very common symptoms in a large number of cases. Or the patient complains of nervous symptoms, such as neurasthenia, irritability, insomnia. Sometimes what the patient first notices wrong with him is neuralgia, rheumatic pains, chest and shoulder pains, with or without some functional heart disturbance. At other times there is hoarseness, tickling in the throat, tightness in the chest, dry cough or asthma. Often the patient gives a history of repeated chills and colds, bronchitis, nasal obstruction, anæmia and disturbed menstruation in women. If there is fever, the patient feels flushed in the afternoon with redness of cheeks followed

by night sweats and subnormal temperature in the morning. In other cases a slight attack of hæmoptysis attracts the attention of both the patient and his physician, which leads to the patient being sent away for a change of air and rest, and to the arrest of the disease. Or an attack of pleurisy or apical pneumonia, which does not clear up, rouses the suspicion of the physician.

Examination for Physical Signs.—The physical examination consists of inspection, palpation, percussion, and auscultation. The patient should be examined in a warm, well-lighted room and in silent surroundings. He should be stripped to the waist, he should assume a natural position, and hold his head in the middle line; he should sit (the writer's method) on a stool or chair raised on a platform, so that the light may fall full on his face and chest from a side window, and in order that the physician need not stoop and be at ease during the examination.

The Inspection would show up any signs of old rickets, deformity of the spine, drooping of the shoulders, retraction or flattening of the chest, or atrophy of the muscles of the neck and chest, or any depression from cicatrization of the lung or limitation of the chest movement; also any facial expression, such as pallor, hectic flush, prominent malar bones, sunken cheeks, etc. The writer lays great stress on the comparison of the distance between the lower margin of the clavicle and the nipple of both sides. Any old mischief is almost sure to show itself by the shortened distance of the affected side as compared with the healthy side; also by atrophy of the chest muscles, flattening, etc.

Palpation reveals a lessened mobility of the affected side of the chest and increase in the vocal fremitus, owing to some consolidation of the lung. In early lesions the upper part of the affected side lags behind in expansion as compared with the normal side; and in advanced cases the movement of the chest becomes still more limited. When in bilateral lesions both sides exhibit a limited expansion there may be some difficulty in detecting this change in the chest. It was Pottenger[12] who first pointed out that the limited

respiratory movement of the affected side may also be due to spasm and tonic contraction of the muscles of the neck and chest, which give a feeling of firmness and increased tension to the touch, and that this spasmodic contraction and prominence depend upon a reflex action of the nerves caused by the inflamed lung and pleura. In advanced cases these muscles and subcutaneous tissue show signs of atrophy, degeneration, and flattening.

Percussion.—The patient sits on a raised chair with arms hanging loosely by his side to allow complete relaxation of chest and shoulder muscles, and his arms folded each on the opposite shoulder when the back is examined. The percussion should be light, the stroke gentle to bring out the delicate shades of resonance and dulness in the small affected areas in early cases. Heavy percussion is only necessary to bring out the dulness of deeper parts or extensive lesion. Only one finger should be used as a pleximeter, which should be in light contact with the chest to prevent the tension of intercostal muscles and placed parallel to the ribs, and the patient percussed from below upwards to bring out the normal before eliciting the abnormal sound at the apices. The writer uses the left forefinger as a pleximeter and the right middle finger as the percussion finger. If there is any doubt about the resonance or dulness, or if the chest muscles are not relaxed enough when examined in the erect position, the patient may be placed in the recumbent position for the examination of the front part of the chest.

In incipient cases the dulness is discovered mostly below the inner third of the clavicle in the first intercostal space extending to the margin of the sternum anteriorly, and over the supraspinous fossa above the spine of the scapula posteriorly, which corresponds to the alarm zone of Sergent, which is situated midway between the tubercle of the trapezius and the space between the spinous processes of the seventh cervical and first dorsal vertebræ. This dulness may extend outwards, downwards, and above the clavicle anteriorly and to the upper part of half of the scapula posteriorly.

The diagnostic importance of percussion should not be exaggerated. There are many conditions that modify pulmonary sounds. The changes in the percussion note can be of real value in the diagnosis of early cases, but as they advance defective resonance or dulness may be brought about by many other affections besides active tuberculosis, such as chronic pneumonia, apical pleurisy, thickened pleura, enlarged glands, minor degrees of curvature of the spine, etc. Also dulness over the right apex may be physiological in children, mouth breathers, in apical catarrh, and collapse-induration, etc. Percussion over thick muscles in stout persons, or muscles thrown into spasm or contraction by reflex action or heavy thumping, may yield a certain amount of dulness which must not be taken for disease. On the other hand, absence of dulness does not indicate an absence of the disease. Cases of disseminated tubercles in the early stage, some cases of acute or extensive softening and emphysematous apex in the chronic stage, etc., may present a higher resonant note. So that percussion findings should be studied and valued in conjunction with other physical signs, especially auscultation.

Auscultation. – Auscultation gives much more correct information than percussion. Dividing the classical first stage into three periods (*a*), we find that the changes in the inspiratory note mark the first period. Weak or rough inspiration and cogwheel breathing over the dull areas mentioned before are the earliest manifestations of incipient phthisis. The weak inspiration is caused by the plasmodial growth (formed from the exudation from thrombosed vessels into the surrounding peribronchial areas) forming tubercles pressing upon the bronchioles. The greater the compression the more feeble becomes the inspiratory murmur. The rough breathing, or granular breathing, as Fishberg and others have correctly expressed it, is due to the tuberculous infiltration invading the air cells and causing an inflammatory condition and roughening of their walls. The cogwheel breathing is caused by the inrush of air separating one by one the inflamed and sticky walls of air cells. The cogwheel

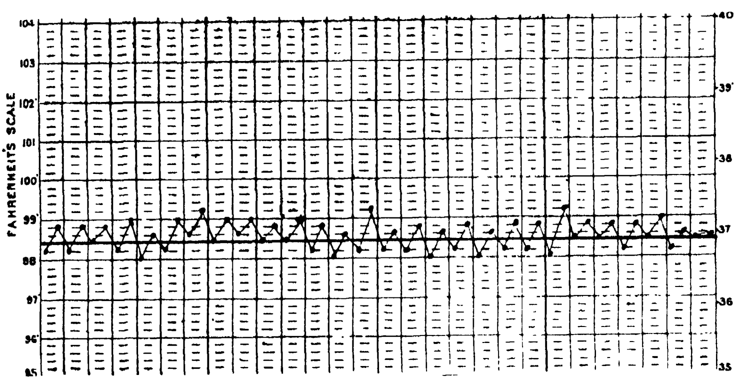

FIG. 12.—SHOWS THE RISE OF TEMPERATURE IN THE EARLY PERIODS OF THE FIRST STAGE.

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or wavy inspiration heard all over the lung in nervous patients, or when patients are first examined, must not be mistaken for the same sound found in early phthisis which is localized and heard only over the affected areas.

(*b*) Expiratory changes manifest themselves in the second period. With feeble, or rough and cogwheel breathing, the expiration becomes rough and prolonged. This harsh, expiratory murmur develops into bronchial breathing if the dulness is more pronounced, and into high pitched and blowing sounds as the consolidation of the lung becomes more advanced.

(*c*) With changes in the breath sounds dry rales make their appearance at the third period. They are dry, crepitant, or crackling rales (like thorns crackling when set on fire), or bright clicks heard at the end of inspiration; they are the indication of early softening of dull areas, and are caused by the forcible opening of the viscid walls of the air cells by the inspired air.

At the end of the third period, or the beginning of the classical second stage, the dry rales become moist or subcrepitant, owing to greater softening of the tuberculous areas when tubercle bacilli appear in the sputum.

To recapitulate briefly the symptoms and signs of early phthisis: Take note of a history of early hæmoptysis or pleurisy, or physical and mental strain, business worry, domestic grief, etc. First period of the first stage is marked by more or less negative symptoms: no dulness or crepitation, no cough or expectoration. The patient is out of sorts, suffers from dyspepsia; there may be evening rise to 99° F., or 99·4° F., especially after the evening exercise. The oral method (of taking temperature) often shows a lower temperature if taken immediately after the evening exercise. Therefore the temperature should be taken before, and an hour after, the evening walk, and the difference noted. Pulse is inclined to be quick. There may be some functional disorder of the heart. The inspiration is weak or rough, and cogwheel breathing is heard below the inner third of the clavicle in front and between the tubercle of the spine and first, second,

and third dorsal vertebræ at the back. Second period: Symptoms of the first period more marked. Evening temperature may go up to 100° F., or more; pulse quick, there may be palpitation of the heart, gastric, and nervous symptoms. Impaired resonance, weak or rough breathing, harsh and prolonged expiration heard over a larger area than in the first period. Third period: Symptoms of the second period more marked. The patient is easily fatigued, feels hot and flushed in the afternoon, evening temperature rises to from 100° F. to 102° F., pulse rate is increased, there is dry or hacking cough. Dulness and impaired movement, harsh or bronchial breathing, expiration prolonged; dry crepitation or crackling rales over affected areas. First period of the second stage: Dulness and impaired movement more marked, harsh, bronchial, or tubular breathing, expiration harsh and prolonged, moist crepitation; the sputum may contain tubercle bacilli.

These periods may not be distinct, but may overlap one another, or the symptoms and physical signs of the first and second periods of the first stage may be present at the same time at different parts of the same or opposite lung; also those of the third period of the first stage and the first period of the second stage may go together, as indicated by dry crackling rales at one part, and moist rales at another part, of the lung. Or these periods may have long intervals of many weeks or months between them, or the interval may be so short that they may follow one another at lightning speed as in acute pulmonary tuberculosis. Or the disease may stop short at the first or second periods when the patient recovers, leaving behind practically no physical signs, or, at most, harsh breathing. Or the disease may go on to the third period and get well, when one finds a certain amount of dulness and harsh and prolonged expiration. Or there may be no temperature during any of the three periods, especially if the early disease is a recrudescence of an old lesion, or there may be temperature at night followed by night sweats and subnormal temperature in the morning. But the question that most concerns the physician is not the theoretical difference

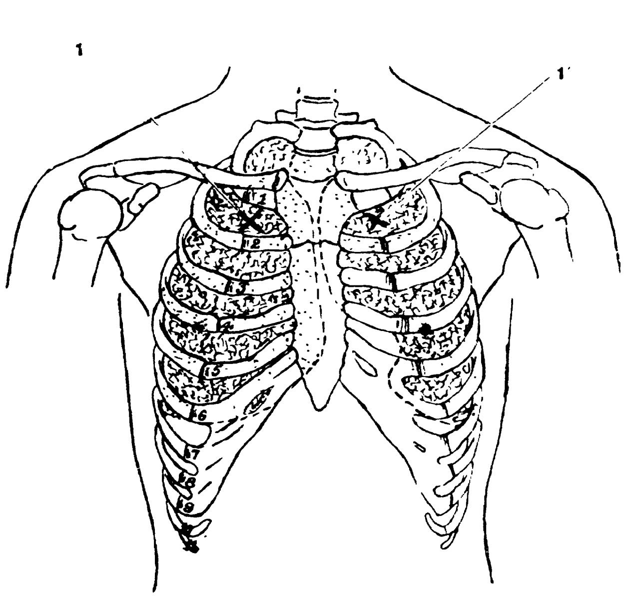

FIG. 13.

1-1'. Areas of dulness in incipient phthisis commencing anteriorly at the first intercostal space below the inner third of the clavicle.

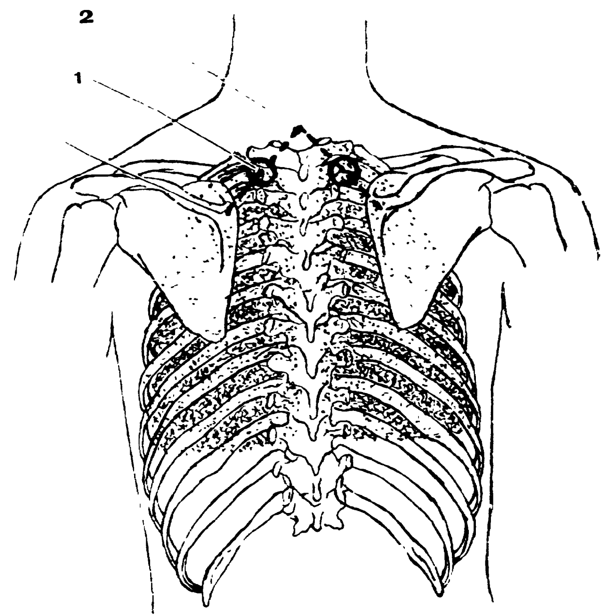

FIG. 14.

1. The "Alarm Zone" of Sergent where phthisis commences posteriorly.

2. The space between the spinous processes of the seventh cervical and first dorsal vertebræ.

3. The tubercle of the trapezius.

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in the signs and symptoms that accompany the various periods; but can the physical signs in the different periods be made out in every-day practice? What do they signify? What is the value and interpretation of these abnormal respiratory sounds in the diagnosis and prognosis of every case of pulmonary tuberculosis? If the trained eye and ear of the physician is necessary to detect the various shades of breath and adventitious sounds, it would require a trained experience as well to interpret correctly their meaning and significance in the diagnosis of the disease.

What one sees in clinical practice is an apparent irregularity, inconstancy, and confusion in the various periods and stages, and in signs and symptoms. There seems to be no time limit or regularity in the appearance of various respiratory sounds. Nature does not seem to work in water-tight compartments. The moist rales sometimes appear before the dry, and the dry rales before the altered breath sounds. Or the physical signs of all the three periods seem to be present at the same time in the same or different parts of the lung. Or the patient has dulness and harsh breath sounds over the right apex for years, and no other signs and symptoms follow, and he keeps in perfect health. Or the patient comes with a history of incipient phthisis when the physical signs indicate that he has had the disease for many years. Or he may have extensive area of dulness and crepitation, but he has no shortness of breath or a rise of temperature or pulse. Or he may have a high temperature and rapid pulse and other symptoms of pulmonary tuberculosis, but no physical signs or tubercle bacilli. If the reader would study the etiology of the disease in the light presented in this volume and keep in mind the following points, they would greatly help him to understand the apparent confusion and contradiction of physical signs and symptoms as seen in the ordinary practice.

1. Nutritional deficiency and lowered vitality alone are sufficient to produce symptoms and signs of pulmonary tuberculosis, which at first is physiological, and becomes

pathological, when the disease persists, owing to the lowered vital powers of the patient.

2. Most of the incipient cases that are seen in practice are a recrudescence of an old lesion perhaps dating back from childhood. Some vicious environment or wrong living has revived the old mischief in the same part, or caused fresh trouble in a new part of the lung.

3. So that when physical signs belonging to different periods appear at the same time, it is because lesions of different periods are present in different parts of the lung; or when rales seem to appear before altered breath sounds, it is either because the patient was seen for the first time in the late periods of the disease, or because the harsh and prolonged expiration is a sign of both recent and old lesion.

4. Therefore do not make your diagnosis and prognosis by the extent of the presence or absence of signs and symptoms, but rather interpret the signs and symptoms of the patient by the condition of his health, by his vital capacity and resisting energy.

1. These points require some explanation. In strumous children brought up on poor and insufficient food and in poor surroundings, in mouth breathers with nasal deformity, nasal obstruction, adenoids, who are unable to breathe properly, and among those living in bad economic and insanitary environment, there is seen an unhealthy condition of the mucous membrane of the nasal, bronchial, and upper air passages, brought on by lack of fresh air and food, and constitutional weakness, and producing an inflammatory condition and catarrh of the apex of the lungs—especially the right side—dulness, lack of resonance, harsh breathing, and even a rise of temperature, bronchial breathing, and dry crackling rales. In fact, these are all the symptoms of early pulmonary tuberculosis, which may end in collapse-induration, or shade off into early phthisis. A little further on in the story of tuberculosis we come across what Bard described as 'tuberculose abortive,' what Fishberg[13] calls 'abortive tuberculosis,' and what has also been mentioned by men like Piery and Bezançon, as a condition a little more severe than

the tuberculosis of the strumous kind described above, and having all the symptoms of incipient tuberculosis—viz., dulness at the apex, impaired movement, dry and moist rales, cough and expectoration, increased pulse rate, and even hæmoptysis, but very often without tubercle bacilli. Again, in many cases of incipient phthisis the patient exhibits all the symptoms and physical signs of abortive tuberculosis, but perhaps with more likelihood of tubercle bacilli being present than in the abortive kind. Looking from a broad point of view, it is impossible to see any vital difference between these three varieties—the strumous, the abortive, and the incipient. Any difference among them is one of degree rather than of kind. They all have more or less the same symptoms and signs in different degrees of severity, and get well spontaneously or under the same improved nutritional and hygienic surroundings, and they all leave behind a certain amount of dulness, more on the right side, impaired movement, and harsh breathing. All these varieties may rightly be called phases of benign or physiological tuberculosis, and are not pathological. Between these three varieties (these divisions are only arbitrary) there may be many shades of early phthisis presenting themselves in clinical practice. If a patient persists in living in vicious surroundings, keeping late and long hours, bearing physical and mental strain, there would be more than one crisis in his life leading to more than one exacerbation of the disease, and the strumous variety may be followed by the abortive or incipient kind and an arrest of the disease, or a fresh attack may be grafted on an old lesion, leaving behind an increase of fibrous tissue, dulness, and altered broncho-vesicular breathing in the affected parts. If we study tuberculosis from the biochemical and nutritional point of view, we shall see that the symptoms, physical signs, and the arrest of pulmonary disease depend upon the extent of nutritional and hygienic disturbance, and the resisting power of the patient.

These many phases of physiological tuberculosis are a puzzle and enigma to those who hold the contagion theory, as they cannot understand the presence of symptoms of

pulmonary tuberculosis without tubercle bacilli. Clinically we must recognize that the presence of tubercle bacilli is not necessary for the diagnosis of phthisis; that symptoms of the disease occur long before tubercle bacilli make their appearance, and that the disease may stop short of their appearance with clinical symptoms alone, and get well or go on to a further stage, when tubercle bacilli may or may not be demonstrated. If we rightly understand the etiology of the disease and the biological phases of tubercle organisms, the presence of the bacilli would not make us any more sure, or their absence any the less sure, of the presence of tuberculosis. It is because our reliance on the laboratory evidence has dulled the faculties of mental perception of seeing and hearing that percussion and auscultation do not very much help us in early diagnosis.

2. Since man in civilized countries does not live on an ideal diet, there must exist some nutritional deficiency among all civilized beings. The smaller the departure from a physiological diet and natural living, the smaller will be the manifestation of a lesion in the lung, and the more readily will Nature be able to arrest the disease. It is quite possible for a patient to recover completely, even after the third period of the first stage, without a trace of physical signs being left behind. Many an early case of this kind is viewed by the physician as a vague indisposition or illness which recovers after a change of air and rest in the country, without the patient or the physician suspecting the nature of the illness. From a long experience the writer is convinced that the large majority of such cases presenting dulness, impaired movement, harsh breath sounds, more often on the right than on the left apex, are an indication of early phthisis (physiological tuberculosis). He is glad to note that Bushnell[14] also is 'inclined to grant a frequent benignity to apical tuberculosis, and to suppose that many of the so-called non-tuberculous induration of this region are really *ab origine* tuberculous.' The classification of tuberculosis into physiological and pathological, rather than tuberculous and non-tuberculous, as done by Krönig and many others after him, would avoid

error and confusion, and would be more in accordance with wider clinical facts and observation, and with the teaching of biochemistry and physiology.

3. There is a difference of opinion among expert physicians as to the earliest physical signs that manifest themselves in incipient phthisis. Some believe with Laennec, Cabot, Goldscheider, and Bushnell,[15] that rales and crepitations are the earliest physical signs of incipient disease, and that dry sounds are signs of apical induration or fibrosis. But Grancher[16] taught that weak or harsh inspiration, and after that harsh expiration at the apices of the lungs, are the very first indications of incipient pulmonary disease, and are followed by moist rales caused by the softening of the tuberculous focus. Osler[17] also says that feeble breath sounds and prolonged expiration are most characteristic of early signs, and harsh, rude, respiratory murmur in other cases. This difference of belief in the order of physical signs among the workers arises from want of agreement as to what an early lesion means, and from confounding primary with incipient tuberculosis. The disease that is commonly seen for the first time in daily practice is not a primary lesion, but very frequently a recrudescence of an old lesion. In many cases that enter a sanatorium the patient shows dry signs on the right and moist rales on the left apex. The dry sounds may be elicited both in the early periods of the first stage and in old lesions; both yield dulness, impaired movement, harsh breathing, and prolonged expiration. But in chronic lesions the side that is affected is generally shorter in the line between clavicle and the nipple, and, owing to greater conductivity of sound from the presence of fibrous tissue and induration, the dulness is more marked, and the broncho-vesicular breathing and prolonged expiration are much harsher. If the breath sounds are somewhat weakened from the compression of bronchioles and air vesicles by dense fibrous tissue, it would be difficult to diagnose chronic from fresh incipient lesion by the dry sounds alone; but the inspection of the chest, the shortened clavicle-nipple line when it exists (it does in many cases), and flatness, depres-

sions, and other deformities would point out that we are dealing with an old healed lesion.

An early case recently sent by Dr. Butler, of Castleford, will illustrate some of the points under discussion. The patient, a young student, aged twenty, studying at Leeds University, was taken queer about Christmas, 1920, when he complained of feeling tired and fatigued, loss of appetite, pains in the knees, dry cough, and loss of weight. His temperature went up to 99° F. during early January, 1921, He began his term on January 11, and after ten days he felt ill, had to give up his study and take to bed, when the temperature went up to 101° F. It came down to normal during the first week in February, and he was admitted into the sanatorium on the 11th. On examination, there was dulness and harsh breathing over the right apex, the clavicle-nipple line was half an inch shorter on the right side, there was dulness on the left side, but not so marked as on the right, rough breathing, cogwheel, dry crepitation, no expectoration. The patient made uninterrupted progress, the temperature and pulse kept normal, he put on weight, the physical signs slowly cleared, and he left the sanatorium in June, 1921. This is evidently a case of an old lesion on the right side and commencing mischief—about the third period of the first stage—over the left apex. Unfortunately the physician does not often get an opportunity to see patients in such early periods of the first stage. If he does, he will agree with Grancher that altered inspiratory and expiratory murmur are the earliest signs of pulmonary tuberculosis. It is because cases generally present themselves for the first time in the stage of crackling or moist rales that Bushnell and others interpret them as the earliest manifestation of pulmonary disease. The real confusion will arise when the patient gets a fresh attack on the same side as he had the chronic lesion, when the presence of dry signs will be masked by moist rales caused by the fresh mischief. Here we get a condition of mixed lesion—of fresh exacerbation grafted upon a healed lesion. Unless the physician is prepared to recognize that pulmonary tuberculosis is not like a zymotic

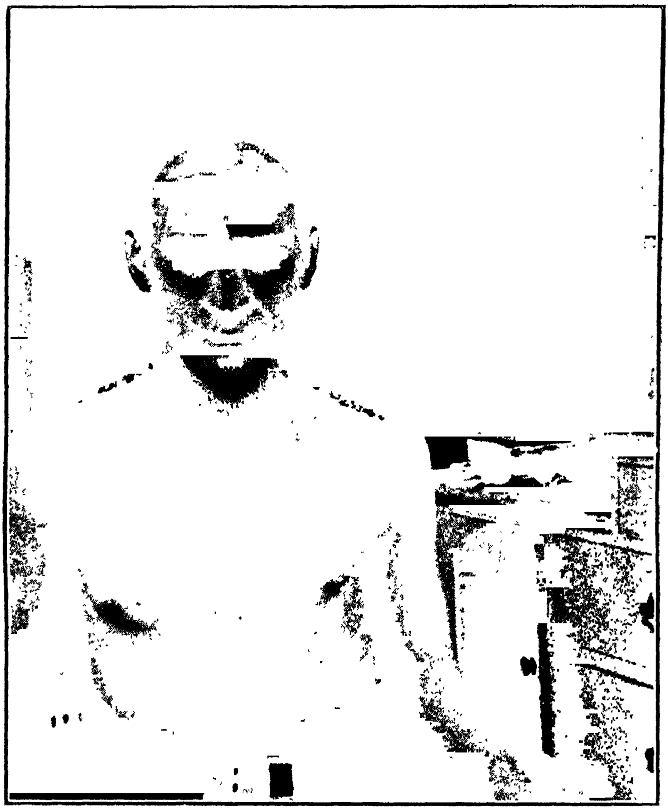

FIG. 15.—CHRONIC LESION ON THE LEFT SIDE WITH THE SHORTENING OF THE CLAVICLE-NIPPLE LINE.

Generally the old lesion and the shortening are noticed on the right side and fresh mischief on the left.

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disease that once appears and does not return again, but presents many exacerbations produced by many crises in the patient's daily life, and is followed by many periods of quiescence, he will not understand fully the significance of the various physical signs that manifest themselves in the course of the disease. Each exacerbation—as seen by symptoms of feverish attack, a feeling of fatigue, gêneral malaise, cough and expectoration, etc.—may, like the mark left on the sea-shore by the receding waves, leave behind some morbid condition, some extension of the disease, or an increase of fibrous tissue if the resisting powers are good. In the latter case, one would notice in patients who are under observation for a long time, a gradual shrinking of the affected side as seen by the gradual shortening of the claviculo-nipple line. But if the exacerbation has been slight or the patient has plenty of vital reserve, there may be no sign of any lesion or contraction of the affected side.

Another kind of difficulty in the diagnosis may arise when chronic lesions are accompanied with little or no physical signs, when they do not seem to correspond to the different periods or stages, when dry rales are present in patients under observation for many years, and when even moist rales, which come and go, are heard over the base of the lungs in those who are healthy. How shall we diagnôse these cases? Bushnell[18] finds that, in the absence of other symptoms and signs, sounds and crepitations heard over the sternum, over the costo-sternal articulation, in the right axilla (the writer has found more often in the left axilla), or the left base, or the angle of the scapula, are not pathological. The presence of impaired resonance, harsh breath sounds, and even rales, may be consistent with perfect health. It is very difficult to draw a line between sounds heard in benign and pathological tuberculosis. Again, in ill-fed children and in strumous conditions, where there is gastric derangement with fever, furred tongue, constipation, etc., an inflammatory condition of the apex may be found associated with rales, which disappear when the patient is put under a proper diet, a course of salts and anti-dyspeptic treatment, and a life in the

open air. We know that a severe gastric crisis in children may be followed by an attack of tubercular meningitis. All these ill-defined and dyspeptic cases suggest that there is a close connection between early tuberculosis and gastric disturbance. Has not Arbuthnot Lane[19] pointed out the association of thyroid deficiency and intestinal stasis with tubercle?

4. Above all, in the diagnosis of pulmonary tuberculosis, the significance of the presence or absence of physical signs and symptoms depends upon the condition of the patient rather than upon the character and extent of the lesion he presents. Even moist rales and other physical signs will not be of much consequence if the patient is in robust health, and their absence will be of serious import if he is weak and running a temperature. So the value of the physical signs should be measured by the man and not man by the signs and symptoms.

Symptoms and Progress.—A larger number of cases of pulmonary tuberculosis take the form of chronic phthisis, develop slowly and insidiously, with ill-defined symptoms, such as fatigue and tired feeling on the slightest exertion, loss of weight, fever, etc., go through many remissions and exacerbations, or remain at the incipient stage for a long time and get well; or some physical and mental strain, exhaustion, accident, or an attack of hæmoptysis may cause the disease to flare up, when it may then take an acute or galloping form and end fatally. It has been pointed out before that early symptoms of consumption, such as hæmoptysis, pleurisy, fever, cough, and expectoration, are part of the efforts of Nature to bring about healing. The pyrexia is not due to bacterial toxins, as there are as many non-febrile cases of tuberculosis with active mischief as those attended with fever. The temperature is rather an expression of Nature's healing efforts as seen in all conditions of hyperæmia and inflammation. Fever and inflammation mean that life is trying to eliminate the disease. As Adami[20] says, the inflammatory process tends towards repair. The symptoms of phthisis make for healing and are physiological if the

patient's vital resistance is good, or they may tend ultimately to become pathological if his resistance is poor. Early phthisis may sometimes take an afebrile course from the first period, or there may be temperature during the first and second period and not afterwards; or it may show itself by repeated colds and recurrent fever. If the temperature does not go up in active disease, it means that either Nature's ordinary efforts are quite sufficient to deal with the disease and to bring about recovery, or it has spent its resources and has not much strength to continue the struggle. For all ordinary purposes the oral method of taking the temperature is quite efficient, provided the patient rests from half to an hour before taking it, and keeps his lips closed for a few minutes and then takes the temperature with a half minute clinical thermometer for about three to five minutes. Generally speaking, the temperature more truly indicates the state of the lung and the system in early cases of pulmonary tuberculosis than when it reaches an advanced stage or a chronic condition. A rise in the evening, however small—to 99° F. or 100° F.—and continued every day for a week, together with early physical signs, is quite sufficient to justify a positive diagnosis. The state of the pulse often gives a truer indication of the progress of the disease than the temperature. In some early cases the quickness of the pulse may be the only symptom to make the physician suspicious of the commencing lung trouble. When the disease passes on from the first to second and third stages it gets complicated during its course with many other intercurrent affections, such as sore throat, pharyngeal and bronchial catarrh, indigestion, constipation, diarrhœa, influenza, pleurisy, pneumonia, etc., any one of which may cause a rise of temperature, which therefore cannot be relied upon as an index to the condition of the lungs or the extent of the disease in the late stages. As the disease progresses, other parts of the body, such as the larynx or the intestines, may get involved, the patient's nervous system becomes increasingly sensitive, the temperature easily loses its balance and goes up for trivial causes, such as an attack of pain, a fit of

coughing, a restless night, constipation, a little extra exertion, etc. Thus the disease that has existed for some months or years may pass on from the physiological to the pathological phase, when the bacterial poisons get mixed up with those of the patient, and the cause and effect of symptoms act and react on the body, undermining its remaining strength. Even at this extremity man's vital powers stand guard unto the last to save the flickering life, if at all possible.

Prognosis.—The prognosis of pulmonary tuberculosis depends mainly upon three factors—the early diagnosis, the patient's environment and heredity, above all upon his own vital resistance.

(*a*) **Early Diagnosis.**—It is quite true that in a large majority of incipient cases, early diagnosis ensures a sure and speedy recovery; but it is not so always. A certain proportion of early cases get steadily worse in spite of all that is done for them. Looking at the prognosis from an economic point of view, we find that the well-to-do classes have an advantage over the poor, in that they can provide means to carry out the open-air treatment for a sufficiently long time without any anxiety, and by so doing they secure a better chance of arrest of the disease. So that the successful response to early treatment depends upon man's vital as well as physical resources.

(*b*) **Environment, etc.**—The prognosis is greatly affected by the patient's environment and heredity. Both nature and nurture can influence his progress adversely or otherwise. Living in unhealthy and overcrowded tenements and slums, poverty, alcohol, a hard and strenuous life, late and long hours, a life of constant fatigue, exertion and excitement, hereditary weakness, previous illness—all tend to drain the vitality of the patient, and lead to an unfavourable prognosis. Manu says that a man can never deny his ancestry. A patient with a bad family predisposition is more handicapped in his recovery than one who has a good family record. Adami[21] also holds that the children of those suffering from advancing tuberculosis are more liable to succumb to tuberculosis than are those of healthy individuals. This experi-

ence may seem to contradict the report of Dr. Bardswell and Mr. John Thompson,[22] who say that 'patients with a consumptive family history enjoy the same chance of recovery as those who have no such history.' In reality there is no contradiction. If a patient's personality and his vital resistance are stronger than heredity, he can overcome a bad inheritance and get well. But if bad heredity is stronger than his personality or even good environment, it would adversely influence the course of the disease. The prognosis very much depends upon the relative strength of the three factors—personality, heredity, and environment—which we have already discussed (Chapter XI.).

Abortive tuberculosis is an incipient lesion of short duration which more or less quickly heals up, thus offering a good chance of complete recovery. Fibroid phthisis generally occurs in the middle age among those engaged in dusty occupations, and is often associated with chronic bronchitis, emphysema, thickened pleura, asthma, much expectoration which may not always contain tubercle bacilli, takes a chronic course, and, except for shortness of breath, the patient feels tolerably well and may live for many years.

The disease stays its hand during pregnancy, but may take a rapid course afterwards in some cases. It is a moot question whether the activity of tuberculosis after child birth is due to pregnancy or to worry and anxiety entailed by motherhood. At any rate, the writer is most reluctant to advocate the induction of artificial abortion in tuberculous women who have become pregnant. He doubts very much if induced abortion can favourably influence the course of active tuberculosis. Professor Forssner,[23] of Stockholm, is right when he says that induction of abortion is a step in the dark. If the prognosis is worse for the pregnant than for the non-pregnant patient, it is more likely due to her social and economic rather than to her physiological handicap. Therefore, if the patient's system could be fortified by good living and improved hygienic conditions, or by entering a sanatorium from the first month of her pregnancy and continuing the treatment for a few months, the chances

of escape from the disease for both mother and child are great. In our experience the open-air treatment affects pregnancy very favourably.

The prognosis of the congestive type of pulmonary tuberculosis is more hopeful than the chronic and anæmic kind. Children between seven and fourteen do well. Tall young men who have suddenly sprung up into maturity find difficulty in overcoming the disease. The prognosis is serious when consumption attacks young people at the time of their adolescence when Nature's increased activities at that period make a heavy demand upon their vital force, but as they ward off the disease every year after twenty the prognosis becomes brighter. Young anxious mothers with large families, mothers nursing their children, wives with family cares and responsibilities, are ill-prepared to meet the disease, and their progress under sanatorium treatment is not so good as that of men who, as bread-winners and feeling that a family is dependent upon them, try everything in their power to get well. The prognosis is bad in acute miliary tuberculosis, acute pneumonic phthisis, and in those cases which can be traced to shock and terrible domestic grief. While care and anxiety retard, a calm and placid temperament helps the healing process of the lung. Provided there is resistance behind, acute forms of tuberculosis, such as those which begin with pneumonia, are more satisfactory and heal more quickly than those which begin as non-febrile cases, and tend to take a chronic course. Clinically speaking, the prognosis very much depends upon the efficient working of the heart and stomach. Without their aid, the physician and the patient are helpless.

The disease is generally more extensive than physical signs indicate. The right side is more often affected at first than the left, though in women the left apex seems to be more often affected than the right. This apparent frequency on the left side, in some cases at least, may be explained by the fact that the right side is more easily cured than the left, and often little or no trace is left behind, whereas on the left side the disease is more persistent, and more readily

detected. Sometimes, if not always, the symptoms are a more accurate guide to the activity of the disease than physical signs. The fever in the physiological stage is a beneficent reaction, and therefore favourable to the arrest of the disease; but in the pathological stage, when the bacterial and the body toxins poison the system, it is a bad omen, especially when accompanied with a rapid pulse. A wiry, soft, and rapid pulse, especially in the morning, is a bad sign —the more frequent the pulse the graver the prognosis. But as it comes down in frequency during treatment, the prognosis becomes more and more hopeful. Hence the pulse is often a surer gauge of the patient's condition and progress than the temperature. Even the pulse in some cases may be normal, and yet there may be active disease. In the prognosis of quiescent or ex-sanatorium cases, symptoms are a better guide than physical signs. If the patient's temperature and pulse keep normal, his sleep and appetite good, he has little or no cough, and is able to carry on his daily work, he can be assured he is doing well, even though he has a few physical signs and is inclined to lose weight—especially if he lives the open-air life and has learnt to take care of himself.

(*c*) **Vital Force.**—Above all, it is not so much the extent of the lesion or the stage in which the disease is found out, as the patient's staying powers, his force of character, his dynamic energy, that decide the prognosis. Given a good resistance man can conquer even a bad and vicious environment. This is why some early cases with few physical signs get steadily worse when there is poor stamina, while some advanced cases recover when there is plenty of reserve force. Those with indomitable will and perseverance seem to get well under the most adverse circumstances, unless their vital powers are undermined by some excess, or physical or mental strain. On the other hand, those with a flabby nature, without pluck or energy or (what is expressive, though it may sound vulgar) 'gumption,' do badly in spite of the best treatment. The disease begins from within, and prognosis depends upon the life-forces that are within. The golden

rule in both diagnosis and prognosis is to interpret the signs and symptoms of pulmonary tuberculosis by the character and personality of the patient, and not the patient by his signs and symptoms.

But what is Resistance?—All the time we have been *writing about it we are either using the word in ignorance or* in a wrong way. Life is not resistance any more than the *flow of* electricity is resistance. In the living organism resistance creates a living force. According to the measure of resistance is the amount of living force which Nature develops. Resistance, therefore, is not the living force, but is the cause of it. Disease causes resistance, and Nature puts forth a living energy to overcome this resistance. It is because the amount of living force which Nature develops is according to the amount of resistance which life meets that we have called resistance the living force. In the lifeless world the greater the resistance the less work a machine is able to do, but in the living organism the greater the resistance the greater the energy which it creates to overcome *that resistance. Inflammation, fever, etc.,* are resistance, and Nature puts forth a healing process according to the resistance it meets. Therefore the process of disease becomes the process of healing so long as Nature is capable of developing this living force which we mistakenly call 'resistance.'

This living force which wells up as the effect of resistance is an unknown entity, and is not the same as physical energy. If so, the physically strong man would seldom have the disease, and the weak and the feeble would go under. Whereas some with robust frames and strong constitution dwindle into a shadow and succumb, while many a weakling survives. It seems to belong to a higher plane than physical energy, and is locked up in the hidden capacities of man, a force which the power of suggestion can reveal and the strength of faith can unlock. It is the operation or withholding of this invisible factor that adds an element of uncertainty in our prognosis of phthisis, when we are surprised at the recovery of some bad cases and are dis-

appointed at the unfavourable turn taken by some early or hopeful cases.

REFERENCES.

[1] 'Certain Clinical Aspects of the Framingham Health Association,' by Arthur K. Stone, *Modern Medicine*, February, 1921, p. 134.

[2] Chemical Pathology, by G. Wells, pp. 173, 174.

[3] Addgren, *Medical Record*, New York, editorial, January 17, 1920.

[4] Sahli, Transactions of the National Association for Prevention of Consumption, 1913, p. 57.

[5] Rabinowitsch, *Ibid.*, p. 48.

[6] Pottenger, 'Diagnosis and Treatment of Tuberculosis,' *Journal Iowa Med. Soc.*, 1917, vol. vii., p. 329.

[7] Klotz, *Modern Medicine*, December, 1920, p. 813, and *Californian State Journal of Medicine*, 1918, vol. xvi., p. 82.

[8] Watson, 'Incipient Tuberculosis,' *Va. Med.*, semi-month, 1917, vol. xi., p. 451.

[9] Boston, *Interstate Med. Journal*, 1914, vol. xxi., p. 330.

[10] Rivers, Three Clinical Studies.

[11] Charrin, *Ibid.*, p. 30, and *Semaine Médicale*, December 17, 1902.

[12] Pottenger, Pulmonary Tuberculosis, by Fishberg, p. 248.

[13] Fishberg, *Ibid.*, p. 365.

[14, 15, 16, 17, 18] Bushnell, 'Tuberculosis: Early Signs,' *Amer. Rev. of Tuberculosis*, August, 1917.

[19] Arbuthnot Lane, the *Lancet*, December 20, 1919, p. 1123.

[20] Adami, Medical Contribution to the Study of Evolution, p. 162.

[21] *Ibid.*, p. 63.

[22] 'Pulmonary Tuberculosis : Mortality after Sanatorium Treatment,' Medical Research Committee's Report, No. 33.

[23] Professor Forssner, 'Pregnancy and Pulmonary Tuberculosis,' *Svenska Tryckeriaktiebolaget*, 1917.

PART II

CHAPTER XIV

A GENERAL SURVEY OF TREATMENT OF PULMONARY TUBERCULOSIS

'All things which are done according to Nature are to be accounted for good.'—CICERO.

'Nature is only conquered by obeying her.'—BACON.

THE universal suffering caused by tuberculosis has stimulated a world-wide interest in the search for remedies to stay its ravages. Since the discovery of the tubercle bacillus, and especially after the introduction of the open-air treatment which has reversed the old belief in the incurability of consumption, the list of remedies that have claimed to be certain cures has been rapidly growing, till at present it is only possible to enumerate a small fraction of them. And commercial enterprise, which takes advantage of every scientific discovery, has still further increased the list of cures, many of which, if not all of them, would have died a natural death had they not been supported by persistent advertisement and by selfish exploitation of man's credulity. So that one can sympathize with the physician and the patient when they stand bewildered before a host of remedies all of which profess to be infallible cures of the disease. Looking over the list, we first catch sight of the claims of various injections—tuberculin injections in various strengths, injection of formalin and other antiseptics, of cinnamic acid, of xylol, arsenic, sodium morrhuate, mercury, etc.; then we come across serum and vaccine therapy; Von Behring's tulase; treatment by X rays, violet rays, or exposure to Finsen's rays and heliotherapy; radium treatment, sugar treatment; the milk and the whey cure; the song cure, etc.

From Germany comes the cure by the injection of turtle tubercle bacilli by Friedmann; from Italy the vaccine serum of Maragliano; from France the vaccine of a virulent living tubercle bacilli by Calmette; Spahlinger's remedy from Geneva; the grape cure from Meran; the koumiss treatment from Russia; a plant remedy from Africa; the garlic cure from ancient India. Or the treatment by drugs, such as calcium, creasote, ichthyol, cinnamic acid, iodine, mercury, dioradin and pneumosan; or the inhalation treatment by formalin, pine, eucalyptus, guaiacol, iodine, etc. Also the claims of various climatic and health resorts. Lastly artificial pneumothorax which is becoming as popular as tuberculin was a few years ago; or surgical treatment by thoracoplastic or of endopleural operations. Many of these remedies, if not all of them, have, no doubt, obtained a certain amount of success, and can produce their votaries and enthusiasts in their support. We cannot assess their merit by setting up any standard of judgment or even by the cures they profess to bring about, as the fact of spontaneous arrest of the disease vitiates all their claims of successful results. The fact is that Nature is tolerant with our mistakes and can dispense with our methods of treatment and bring about healing in spite of our blunders and remedies. As in etiology, the main lines of treatment which we shall consider here can be grouped more or less on the contagious or constitutional theory of tuberculosis.

1. Principles of treatment based on the germ theory: Notification, segregation, tuberculin injection, vaccine therapy. Artificial pneumothorax.

2. Remedies based on constitutional theory and considered in the following order:

Sanatorium treatment:
- (*a*) Fresh air.
- (*b*) Rest.
- (*c*) Exercise.
- (*d*) Diet.

(*e*) Drug and inhalation treatment.
(*f*) Psycho-therapy.
(*g*) Results of treatment; climate; after-care,

1. **Notification.**—Those who advocated the notification of consumption in the belief that it would help in discovering incipient cases for early treatment and thus would prevent the spread of the disease will be disappointed at the results as seen by the small ratio between the number of notifications and the actual number of deaths recorded in many English counties. For instance, one county in England showed that for every 100 deaths there were only 104 notifications, another county registered 128, another 130, and still another 136 to every 100 deaths, so that as a writer in *Tubercle* says only a few more cases are notified than die in each year.[1] Yea, more, the number of notifications as seen from the adjoining table were declining every year, while the number of deaths went up steadily from 1914 to 1918.

NOTIFICATION AND MORTALITY OF TUBERCULOSIS IN ENGLAND AND WALES.

	Notification of Tuberculosis.	Notification of Phthisis.	Tuberculosis Mortality.	Phthisis Mortality.	Standardized Phthisis Death-rate per 10,000 Living.
1914	105,525	81,159	50,298	38,637	9·93
1915	96,402	73,538	53,562	41,050	11·53
1916	96,256	72,479	52,898	40,747	12·30
1917	95,750	73,654	54,761	42,152	13·83
1918	92,132	72,741	58,073	46,077	15·20*

From this table we learn that while the notification of phthisis had gone down from eighty-one thousand in 1914 to seventy-two thousand in 1918, the mortality of phthisis had gone up from thirty-eight to forty-six thousand during the same time.

The failure of notification is not, as is alleged, due altogether to want of time on the part of the physician, or his want of clinical ability, or unwillingness to notify. He is not sure of the grounds of notification. Should every case

* The figures for 1919 are: Notification, 77,511 ; for 1920: Notification, 73,332. Deaths from tuberculosis : 1919, 46,312 ; 1920, 42,545.

of tuberculosis be notified? If early cases should be notified, how can they be recognized? The family physician may not be conversant with what the specialist would consider early signs of the disease. In some cases even specialists themselves may diagnose differently; who, then, is to decide that the patient is suffering from consumption? If the presence of tubercle bacilli is to be the deciding factor of notification, clinical symptoms may be accompanied by no sputum or tubercle bacilli for months or even years, or the case may be a closed tuberculosis, or tubercle bacilli may be present one day and absent for many days even after a careful search; would these be considered free from consumption? While writing these lines a case is seen where the patient gives a history of cough, expectoration, emaciation, general debility for some months, and on examination there is found old mischief on the right apex with dulness, harsh and prolonged respiration, crepitant rales more marked on the right than on the left apex above and below the clavicle, but no fever and very little expectoration—a case of chronic pulmonary tuberculosis grafted on an old lesion which is neither active nor quiescent. The patient and her friends would naturally resent being told that she is consumptive, as she feels well and goes about her daily work without inconvenience, and the lung trouble does not show itself in active clinical symptoms. This is typical of a very large number of chronic cases which do not generally come under the physician's notice; should these be notified? The absence of tubercle bacilli is not necessarily a proof against the presence of active tuberculosis, and their presence does not necessarily make a man an invalid or preclude him from going about and doing his daily work. It is futile to base notification on the presence or absence of tubercle bacilli, and even clinical symptoms may not be marked in many semi-active cases.

Another reason for the failure of notification of early cases is that it is but human for the consumptive patient to put off going to see the physician to the last moment from fear of his true condition being found out and of his being subjected

to ostracism and social boycott. For the panic-mongers have kept up an ignorant agitation about the contagiousness of phthisis, and have frightened the public into the belief that every consumptive is a hot-bed of infection to be avoided at all costs. This senseless propaganda has been so successful that men have been turned out of an hotel for a mere innocent cough, and employers and even relatives and friends have been known to treat the cured patients as social outcasts and lepers.

But the most important reason of all is that all anti-tuberculous measures based on the germ theory have not been a success. Professor Ugo Mariotti,[2] of Rome, speaking at the recent Congress of Hygiene at Trieste, 'mercilessly exposed the fallacy of regarding notification as a useful measure in the absence of a concerted programme of dealing with tuberculosis,' and said that as an 'antimicrobic prophylaxis, whatever its theoretical justification, it is devoid of actual practical value.' And Bracken[3] says that notification would not even have a theoretical value. It only causes, as the writer foretold eleven years ago, unnecessary vexation and distress to the unfortunate sufferers who are already handicapped in life with a terrible disease. No wonder some of the Latin countries do not favourably regard compulsory notification, which, when introduced in France, met with almost unanimous opposition from the medical men.

Segregation.—So also there is no justification for the belief that segregation would help to diminish the spread of tuberculosis. With the decline in the belief of aerial transmission of zymotic fevers the policy of segregating those who are suffering from them is also doubted at the present day. Dr. James and Dr. Killick Millard[4] have shown that isolation has failed to reduce materially the prevalence of typhoid, and that measles and scarlet fever have rather increased in spite of notification and isolation. Segregation took no part in the decline of tuberculosis in the past, and therefore it should not be invoked as a measure that would prevent its spread in the future. Dr. James Wheatley,[5] the medical officer for Salop, was driven to the conclusion that

the isolation in asylums and workhouses has not been a prominent factor in the decline of phthisis in Shropshire during fifty years. Dr. Niven,[6] of Manchester, is also unable to accept the view that the great reduction in the phthisis death-rate is due to segregation, and points out that if the three divisions of the city (Manchester) be compared over a long period of years, there is but little improvement in the phthisis death-rate in the Manchester township, the poorest area, in which segregation has been far the most largely employed. Dr. Menzies,[7] in his report on tuberculosis in London, 1919, draws attention to Bulstrode's Supplement to the Local Government Board Report, 1907-08, and says that the evidence up to the year 1908 clearly suggested that if segregation was to be credited with a share in bringing about a decline of the phthisis death-rate, the rate of that decline should be augmented during the next ten years (1908-18); that in fact the reverse of this has proved to be the case, the rate of decline instead of increasing has slowed down and apparently is now rising. Segregation may be justified in advanced cases occurring among the consumptive poor, who live in crowded tenements and unhygienic conditions, with no one to look after and nurse them; but we know that isolation of such advanced cases, when home conditions are unfavourable, is difficult to carry out as a practical measure.

But those who believe in contagion are in a dilemma at present. While some of them believe that exposure to tuberculous infection is dangerous, others say it is beneficial. They really cannot have it both ways. If the exposure to infection is beneficial, because it leads to the production of immunity, why segregate? Besides, tuberculosis, according to Calmette, can be spread by healthy people who can become carriers of infection, and since the whole civilized world is potentially tuberculous there must be some thousands of healthy carriers—whom are you going to segregate? When isolation was the only weapon available, as in scarlet fever, measles, etc., epidemics were as common as ever.[8] As we have already seen, stringent

notification and segregation of consumptives were tried two or three centuries ago on the Continent, but they achieved no success in the prevention of the disease.

Again, when the contagionists in their enthusiasm preached a holy crusade against consumption, the public believed them, and, taking them at their word, shunned every consumptive and barred the door against him in hotels, boarding-houses, and even private houses, and would not let him live near them or sell a piece of land to any tuberculous institution. The contagionists, alarmed at the mischief they have created, are now trying to calm the fears of the public by saying almost the opposite to what they declared before—viz., that the disease is not so contagious and that there is not much danger of living near consumptives, etc. What can the world believe? The mischief has already been done by creating unnecessary suffering and wretchedness to thousands of innocent victims of phthisis. So the world moves, spending half its energy in creating evil and pain, and the other half in trying to rectify them.

Not only has segregation brought no benefit in the past, but psychologically it is a wrong step to apply it to consumptive patients. To segregate is a mistake. In New York[9] many blind children have been educated in ordinary schools with children who are not blind, and the experience has been so favourable and advantageous that it is said that other communities have followed suit. In asylums for the mentally weak and insane, the curative influence of associating the inmates with people with sound minds and sound bodies has been noticed and approved of by men like Bernard Hollander. It is equally important, from a psychological point of view, that a tuberculous patient should mix with healthy people and not be isolated in a consumptive institution or colony. Health breeds health, and sickness breeds sickness. Place an old woman to nurse a young child, the child will unconsciously imitate the nurse's old ways and will begin to look old. The very association of a consumptive with healthy and cheerful people will subconsciously tend to buoy up his spirits and bring confidence and

health. This is why sanatorium doctors, nurses, and others attending tuberculous patients should be free from tuberculosis and should carry a healthy countenance and sunny disposition. Health is contagious; the real contagion for good or evil is through the mind. If medical men are psychologists, they will not countenance for a moment any segregation of consumptive people, even if it bring any advantage. Since it brought no benefit in the past it is folly to continue with it.

Tuberculin Treatment.—The experience of medical men gathered from many sources goes to show that tuberculin injection has no specific value in the treatment of tuberculosis. The Medical Research Committee,[10] from results obtained at King Edward Sanatorium, Midhurst, which covered a period of twelve years—a period which contained the most complete account of results of sanatorium treatment that has been published—found that the evidence for the value of tuberculin treatment is completely negative. Lydia Rabinowitsch,[11] experimenting upon tuberculous rabbits and guinea-pigs, found that no curative value had been exercised by tuberculin. She goes further and says the tubercle bacilli may be caused to enter the blood stream by the injection of tuberculin. Fishberg[12] says that in private practice, as well as in most tuberculosis clinics in American cities, attempts with tuberculin failed, evidently because good surroundings, fresh air, proper food, and regulation of exercise were of more importance than tuberculin. Sir James Kingston Fowler,[13] speaking from his experience at the London Brompton Hospital, says that 'tuberculin did not favourably influence the course of the disease in the majority of cases.' Bardswell and Thompson,[14] in the report on 'Mortality after Sanatorium Treatment' at Midhurst, compare the results of ordinary sanatorium treatment with sanatorium treatment combined with the use of tuberculin, and find that the statistics reveal no appreciable effect for good or ill exerted by the injection. And we can multiply evidence from so many quarters that one cannot help asking: Where are those who at one time proclaimed with every

breath the marvellous specific effects of tuberculin and contemptuously passed by those of us who timidly opposed its use? In some cases, 'the effects of tuberculin,' as Sir James Fowler says, 'were detrimental' and even dangerous by exciting a strong reaction, such as rigors, fever, hæmorrhage, and extension of the disease. When we realize that a great many people living in the towns are potentially tuberculous, we can understand that a dose of tuberculin may, in some cases, be like setting a match to the fire that is already laid. Again, it is questionable how far it is right to impose upon a patient, who is already struggling against disease toxins, an additional burden by injecting more toxin into his system. Besides, how is it possible to expect an injection of a syringeful of emulsified bacilli to purify the whole current of living blood, and regenerate a constitution that has been going wrong for many months and possibly many years? To expect to raise the patient's resisting powers by a course of tuberculin, when his health is broken down and his vital powers lowered, is like trying to squeeze money out of a bankrupt, or whipping a tired and hungry horse to do more work. Further, it does not seem to be reasonable to inject back into the system what Nature has thrown out as poison. Lastly, looking from an ethical point of view, if man is more than a rabbit or guinea-pig, if his body is a temple of the indwelling Spirit, is it not doing violence to his higher self by polluting such a sacred body with inoculations which savour more of witches' concoctions of the crude Middle Ages? What is ethically wrong cannot be scientifically right, and when both ethics and science are against the injection treatment, it cannot surely be justified. Our experience of tuberculin treatment has been so disappointing in the past that we have not used it for many years, and we are glad to find that it is being abandoned by tuberculosis officers, consumptive hospitals, and sanatoria in England and America.

Vaccine Treatment.—So also the vaccine treatment, the serum treatment of Maragliano, and of Marmorek have produced very disappointing results. Immunity reactions

do not produce a cure. The heavy mortality figures for Scotland, England, Germany, Ireland, and France (111, 116, 142, 172, and 179, respectively, per 100,000 in 1915) do not bear out Metchnikoff's theory of immunization produced in thickly populated countries by means of a natural vaccination.[15] Sir Almroth Wright[16] sees many difficulties which stand in the way of accurately forecasting the effects of the inoculation of a bacterial vaccine. And Dr. Alexander Francis[17] goes further and testifies that the continued use of vaccine does incalculable harm. The value of injection treatment may depend upon the psychic effects it produces upon the patient rather than on any specific efficacy inherent in its administration. Or any good results claimed by injection may have been produced by the spontaneous cure of the disease, or could be equally well obtained by open-air methods alone as we have proved in many cases besides pulmonary tuberculosis. One case stands vividly before our mind as we write—a case of tuberculosis of the kidney which the medical man sent suggesting a course of tuberculin injections, but which got quite well under the open-air treatment alone. All methods of treatment by injection are like working in the dark. The discoverers of various injections and vaccines have from time to time been startling the public with the cry, 'lo here,' and 'lo there,' and when sick humanity rushes eagerly after these remedies, it finds to its disappointment that they are only gaudy bubbles which vanish when they are pricked. Nature cannot be tricked by these short cuts. We cannot exorcise evil by injecting more evil. It is not in the power of the laboratory to renew life and healing. The development of vaccine therapy may prove to be, as Sir James Mackenzie[18] says, 'but a reversion to the empiricism of bygone times,'[19] and detrimental to the best interests of humanity.

Artificial Pneumothorax.—The recent development of artificial pneumothorax is still in its experimental stage, and, therefore, it is too soon to assign its true value and its right place in the treatment of pulmonary tuberculosis. One is a bit inclined to be sceptical of the high praises given to this

new treatment, as they remind one of tuberculin treatment in its popular days, which, with many other measures, has since fallen from its high pedestal. It may be useful in a small number of selected cases, although some enthusiasts are clamouring that its use should be extended even to early cases. If the main aim in the cure of tuberculosis is early diagnosis and early treatment, no case should be allowed to advance so far as to require any surgical interference. Besides, our contention is that tuberculosis is a constitutional disease and requires constitutional treatment for its eradication; and it is not in the province of artificial pneumothorax to increase man's vital force or strengthen his resisting power which really should be the basis of all treatment of pulmonary tuberculosis.

There is no royal road to the cure and arrest of tuberculosis. Nature's way of arrest is the only sure and certain way. Man cannot improve upon her methods. Just as in the opening chapter we alluded to the vigorous up-rush of the spring sap which slowly displaced the brown leaves that cumbered the tree so that its naked limbs were clothed with a mantle of living beauty, so Nature attempts to restore the patient's health and strength by bringing new blood and vitality into his withered frame. Hence the importance of the open-air treatment which was introduced into this country some twenty-four or twenty-five years ago and has revolutionized the entire outlook presented by tuberculosis. If the treatment of the disease has not progressed with our knowledge of the disease, it is because our etiology of the disease in the past was wrong. Nearly sixty years ago C. T. B. Williams in his Lumleian Lectures (1862) struck the right note when he said:

'The more fully we recognize the relations of the disease to the general economy, and the less it is treated as a local affection, the more likely are we to progress. The proper treatment of phthisis seems to be that which is calculated to improve the nutrition, to elevate the condition of health. For the fulfilment of this object we must

have an eye to the influence of food, clothing, and air, bodily and mental discipline.'

When once it is realized that disease processes are within us, that tuberculosis is a disease of nutrition, of vicious, social, and economic environment, medicine will begin a new era, a new outlook; and the treatment of the disease will proceed on right lines. It will abandon all anti-bacillary measures, strengthen the hands of open-air and social movements, and concentrate its energies in improving the patient's living conditions and his physical and moral environment.

Open-air Treatment from Ancient Times.—The value of fresh air in health and disease has been recognized and understood from olden times. It is as old as the ancient Indians and Greeks, who lived the open-air life, and whose public gatherings and places of amusement were all in the open air. The ancient Yogis in India believed that consumption and other diseases were due to lowered vitality, brought about by breathing an insufficient amount of air, and therefore they paid great attention to correct habits of breathing. They also believed that breath was life, and that fresh atmospheric air, in its freest state, was charged with a universal principle of life, or vital force, called *prana*, which is allied to the breath of life mentioned by the Hebrew writer of Genesis ('And the Lord God . . . breathed into his nostrils the breath of life,' Gen. ii. 7), and which, when stored in the body, radiates strength and vitality, and develops latent faculties and psychic powers. So great was their faith in fresh air in health and disease that they gave minute practical instructions on various breathing exercises, and founded whole schools of philosophy on the science of breath. We read of Hippocrates recommending rides on horseback, and of Celsus advising sea-voyages. Coming nearer to our own times, we find Laennec advocating living by the sea in cases of phthisis. All these must have had an idea of the benefit of the open air. In 1747 a Scotch physician is said to have written to his friends that the most important factor in the treatment of consumption was fresh

air and diet. In a treatise on 'Domestic Medicine,' Dr. William Buchan, in 1783, wrote that 'on the first appearance of consumption, if the patient live in a large town or any place where the air is confined, he ought immediately to quit it, and to take choice of a situation in the country, where the air is pure and free.' The doctrine of the open window was taught by James Graham in 1784, who recommmended people to sleep with all the windows of their rooms wide open.

In 1840 George Bodington, of Sutton Coldfield, England, read an essay on 'The Cure of Pulmonary Consumption,' and tried to convince his medical brethren of the curability of the disease, and the importance of fresh air, day and night, and of nutrition and of easily digested food in its treatment. He may be rightly called the father of the open-air movement. Other prophets of fresh air arose in turn, chief among whom may be mentioned the names of Dr. Henry McCormac, of Belfast, and Sir. Benjamin Ward Richardson, of London, who shared the same fate of ridicule and contempt of their brethren for their opinions and enthusiasm.

In 1859 Hermann Brehmer, in spite of great opposition, gave practical expression to his open-air views by building the first sanatorium for fresh-air treatment at Görbersdorf, in the Waldenburg Mountains, and he thus became the father of the sanatorium treatment of consumption.* He was followed, among others, by Dettweiler, of Falkenstein, Trudeau in the United States, Carl Spengler at Davos, and Otto Walther, of Nordrach, who popularized and worked out the details of the treatment. Their success spread all over Europe, and at last England caught their inspiration, with the result that within twenty-five years of its inception sanatorium institutions have become an important part of the treatment of tuberculosis.

* Prior to Brehmer, Bodington is said to have opened an establishment for the reception and treatment of 'consumptives,' but the medical profession then was so hostile to his methods of treatment that, according to Dr. Carlo Ruata, he had to transform his hospital into a lunatic asylum.[19]

The Rationale of the Open-air Treatment.—1. It is a natural treatment. The secret of its widespread interest in Europe is due to the discovery—if discovery it may be called—that fresh air, hitherto regarded as an enemy to be shut out and barred, is really a friend, and one of Nature's best gifts to man, without which life slowly fades and disease lengthens its stay; and that man, by building towns and manufacturing dirt and disease, is undoing Nature's work, and that to put himself right again he must go back to Nature, and lead an open-air life in the green fields and meadows, and breathe the sweet fresh air.

2. It is based on a sound, rational foundation. It is Nature's mode of cure. She sends out her sick children into the fresh air and sunshine. When a horse is ill, we turn him out into the fields; when a native in Oriental countries becomes indisposed, he quietly leaves his relatives and friends, and goes over the hills and mountains, as the saying is, and returns when Nature has nursed him back to health. Even to the present day natives in many parts of Africa and India worship the sun as the source of all life and energy, and bring out their sick relatives and old people into the open air and sunshine. Fresh air and sunshine are therefore Nature's physicians, and when the Occident now turns its attention to the treatment of consumption by fresh air, it is merely adopting Nature's methods and ways, which it has long forgotten, and from which it has wandered these many years, much to the detriment of the physical and moral well-being of its children.

3. The open-air movement is in line with all the psychological, ethical, and spiritual activities that make for a wholesome and happy life. It does not kill disease by introducing more poison, any more than crime can be cured by inflicting more punishment. Through deranged blood arise diseased conditions, and through a vigorous and healthy blood alone can health return. Living in the atmosphere of pure air and quiet surroundings of country life, a new life, a current of fresh blood courses through the shrunken vessels which casts off the disease and creates a natural immunity, in the same

way that by living in an atmosphere of goodness, sympathy and love, man obtains a new motive power, a new strength by which the effects of evil are neutralized and gradually overcome.

Sanatorium Treatment and Pulmonary Tuberculosis.—The best results of the open-air treatment are obtained in a well-conducted sanatorium, where all the means and appliances are available to carry out the treatment to the fullest possible extent. There has been a controversy as to how far the success that was expected by the founders of the sanatorium movement has been realized, and a doubt expressed in some quarters as to the efficacy of the open-air movement. Laymen, encouraged by the early enthusiasts of the movement, expected that everyone entering the portals of the sanatorium would be cured in a very short time. And even medical men, without giving a due consideration to the question, were led away by exaggerated reports, and proclaimed in private and in public that a few weeks' stay in an open-air establishment would be sufficient to cure a consumptive patient. The inevitable consequence was that the results fell short of public expectation, and discredit most unjustly fell on the whole movement. The truth is that in many of the reputed cases of failure it was not the sanatorium that was at fault, but the conditions that interfered with the treatment and made it impossible. Every method of treatment has its limitations, and sanatorium treatment is no exception. It can no more cure all cases of consumption than a cascara pill can cure every case of constipation. But I venture to say, without fear of contradiction, that in very few methods of treatment have there been such marvellous results in the past, and such abundant cause for hope of success in the future, as in the open-air treatment for consumption.

In What Ways has it been a Success?

1. The Sanatorium treatment has taught the patient to husband his resources and to economize his resisting power by well-directed effort, and has helped him to increase it

prudently, like a thrifty housewife, and to concentrate all the energy thus obtained to overthrow the disease.

2. The results of the treatment have been very encouraging. Seeing is believing. If only a sceptic could have seen with me some of the seemingly hopeless cases on admission to the sanatorium, and again seen the marvellous change for good that came over them six months after they had been treated there, he would have become converted and be as enthusiastic as I am in the conviction that no other remedy known at present has been so successful in saving so many lives from a sure and certain death. Where it has not arrested the disease, it has helped to improve the health of the patients and prolong their lives, making their condition more bearable and comfortable.

3. The value of the fresh-air movement is not to be gauged merely by the number of lives it has saved or prolonged. Its scope extends further. It is wonderful that within a few years of its existence it has been the means of revolutionizing the ideas of society and the nation with regard to the value of fresh air and health. It has made people think, and has made them resort to simpler and more natural modes of living. It has given an impetus to individual, social, municipal, and national reforms that make for the health and well-being of the citizen and nation.

4. The open-air movement has given birth to new ideas and enlarged the outlook of life. It has made the nation see the folly of crowding into towns and cities, and of shutting out God's best gifts to man as if they were poison. When patients have been educated in a sanatorium as to the right modes of living, and have returned home, they in turn become teachers to their own household, showing them the benefits of living in the country, and of sleeping with open windows. Thus each patient, as with ruddy cheeks and returned health he faces a circle of friends, becomes an apostle of fresh air and sunshine, and silently helps to bring about a revolution which aims at the happiness of home and the community.

5. The open-air movement in no small way inspired the

idea of garden cities and recreation-grounds and parks, open-air schools and camps, which are everywhere increasing in number. It has enabled the municipalities and corporations to prohibit spitting in public conveyances. It has strengthened the hands of the pioneers of better sanitation and hygiene in their thankless task. It has brought the builder into line with the new movement, so that he may build houses not only artistically, but with a view to better ventilation and admittance of more sunshine. It has encouraged the municipal reformers to abolish slums and rookeries, and to beautify their towns and cities with gardens and open spaces.

6. When the people of this country begin to realize fully that fresh air is somehow or other connected with healthy life and the building up of a more perfect humanity, they will go further, and extend their reforms from the cure of one disease to the prevention of all disease. They will set to work to remove such evil factors as keen competition, overcrowding, poverty, drink, etc., which form a vicious circle with tuberculosis, and, in fact, with all disease. Thus the open-air movement has a boundless horizon, a wide outlook in the future. Instead of being considered a failure, it will prove itself to be one of the most important ideas of the age, bringing untold blessings in its train. Like a stone dropped into a still lake, it will set in motion influences and reforms which will extend with ever-widening circles, transforming the habits of life and the character of man and society, so contributing to the physical and moral efficiency of the nation.

REFERENCES.

[1] *Tubercle*, March, 1920, p. 282.

[2] *Ibid.*, September, 1920, p. 582.

[3] Bracken, *American Review of Tuberculosis*, 1918-19, p. 107.

[4] Dr. James and Dr. Millard, *The Lancet*, July 18, 1908, pp. 159-160.

[5] Report on Phthisis in the County of Salop, by James Wheatley, 1907.

[6] Supplement to the Annual Report of the Local Government Board, 1905-06, p. 247.

[7] 'Tuberculosis in London,' by Dr. Menzies, p. 7: Report of the County Medical Officer of Health and School Medical Officer for 1919.

[8] *British Medical Journal*, May 12, 1917, p. 631.

[9] *Modern Medicine*, July, 1919, p. 259.

[10] Medical Research Committee, Fourth Annual Report, 1917-18.

[11] Transactions of National Association for Prevention of Tuberculosis, 1913, p. 48.

[12] Pulmonary Tuberculosis, by Fishberg, p. 545.

[13] Sir James Kingston Fowler, Transactions of National Association for Prevention of Tuberculosis, 1913, p. 94.

[14] 'Pulmonary Tuberculosis: Mortality after Sanatorium Treatment,' Report of Medical Research Committee, No. 33.

[15] *Edinburgh Review*, July, 1918, p. 126.

[16] Studies in Immunization, by Sir Almroth Wright.

[17] Dr. Francis, *British Medical Journal*, August 16, 1919.

[18] Sir James Mackenzie, *British Medical Journal*, June 4, 1921.

[19] *The Practitioner*, August, 1921, p. 145.

CHAPTER XV

THE PRINCIPLES AND PRACTICE OF SANATORIUM TREATMENT

'The most wholesome physic of thy health-giving air.'
Love's Labour's Lost, i. 1.

'Now I see the secret of the making of the best persons:
It is to grow in the open air, and to eat and sleep with the Earth.'
WALT WHITMAN.

THE sanatorium treatment is based on sound hygienic and scientific experience. It is no quack remedy that is popular to-day and will pass away to-morrow, for it is founded upon the rational principle that the open-air life is the most natural and hygienic life, and one in which the body fulfils its highest physiological perfection and development.

The following four chapters will be mainly devoted to the description of the principles of sanatorium treatment and the practical side of sanatorium life as carried out by us on the Mendip Hills. The objects of the sanatorium treatment are, briefly: (1) To carry out in daily practice the lessons of the open air; (2) to follow closely Nature's footsteps in the restoration of health; (3) to economize all the resources of the patient to the fullest possible extent; (4) to reduce to a system the various elements of fresh air, food, exercise, and rest, so that they may be administered by the physician according to the requirements of each patient.

These aims are put into practice in the following four main lines of our treatment:

1. Open-air measures.
2. Various forms of exercises.
3. Continuous inhalation.
4. Psychological treatment.

Open-air measures improve the general condition and nutrition of the patient. Various forms of exercise increase tissue resistance which makes for healing and natural immunity. Continuous inhalation gives further aid in the cure and arrest of the disease. Psychotherapy supplies dynamic force from the mind and puts a finishing touch to the whole treatment.

The life of the patient in the sanatorium is roughly divided into three periods:

(*a*) **Resting Period.**—When the patient arrives at the sanatorium he generally feels ill and out of sorts, is pale and overworked and often under-nourished. This is the resting and feeding period. The temperature and pulse are regularly taken. He goes for his daily walks and exercises, but rests more. Time: three months or more.

(*b*) **Exercise Period.**—When temperature and pulse are brought down to more or less normal, and various forms of exercise are in full swing. The patient is getting into a fit condition to do justice to a more or less full sanatorium programme. While he rests he is kept efficient by a carefully regulated exercise. Time: three months or more.

(*c*) **Convalescent Period.**—Here the patient has nearly finished his sanatorium régime. His temperature and pulse are not taken; he does very little inhalation treatment. He goes for long walks, walking tours, tramping, etc. Though kept under medical supervision, he is given more liberty.

Thus the patient is taken step by step, from one period to another, till the cure or arrest is accomplished, and he is ready to leave the sanatorium to resume his duties.

Preliminaries to Treatment.—Patients are advised to wear light, warm, and loose clothing, and to avoid clothes made of black, red, or yellow material—especially anything in the nature of black—as they prevent the sun's rays from reaching the skin and acting beneficially on the system. They should wear light tweeds, and flannels in light grey, fawn, or light green. In the summer, cream or white material may be preferred. The gentlemen are recom-

mended to shave off moustache and beard, and to wear flannel shirts, with soft collars to keep the neck free. The body resents anything tight round the neck or the chest, so all tight-fitting dresses should be banned. It is better for the ladies to wear short rational stays or ribbon-stays—if stays are to be worn at all—so that the expansion of the lung may not be impeded.

Walford[1] points out that any pressure on the pneumogastric nerves, caused by tight neckwear or high collars, especially when the chin is pressed on during bending to read or write, brings about headache, giddiness, rheumatism, eczema, all of which are rapidly cured on removal of the neck pressure. He also says that even phthisis is mechanically produced by the compression of the trachea, causing an insufficient supply of air and oxygen to the system, and imperfect digestion and malnutrition. There is no doubt that tight clothing round the neck and chest interferes with the free entry of air and normal circulation. In the matter of dress women have shown much wisdom in discarding collars and wearing short skirts, loose, low-necked blouses, and altogether less clothing than men.

Centuries of wrong clothing have brought about an unnatural habit of breathing which has contributed in no small way to the predisposition to disease, and dress reform should form part of the education if prevention of disease is to be the ultimate aim of civilization.

The following is the daily programme of the patients in the sanatorium :

7.30.—Patients take temperature while in bed.
7.45.—Physician goes round.
9.—Breakfast.
10.—Breathing and singing exercises.
10.15.—Graduated exercises.
11 to 12.30.—Morning walk.
12.30 to 1.30.—Silence hour.
1.30.—Dinner.
2.15 to 3.45.—Rest after dinner, recreation, games, etc.
3.45 to 4.—Breathing and singing exercises.

4 to 6.—Tea and evening walk.

6 to 7.—Silence hour.

7.—Supper.

7.45 to 9.—Recreation. Patient's own time.

9.—Bedtime.

9.30.—Lights out.

From this it will be seen that an ordinary patient is occupied with the daily routine during the whole day, so that time does not hang heavily on his hands. This programme is slightly altered in the summer, and also in individual cases, according to temperature, etc.

(*a*) Fresh Air.

Of all the agents used in the sanatorium treatment, fresh air comes first and foremost. The whole of the treatment is based upon it.

An Italian proverb truly says that 'air is more necessary than bread.' It is well known that pine trees planted in industrial cities wither and die from being choked by the carbon and sulphur products in the air; even in country districts if they are thickly planted some of them die from sheer want of air and light. These are as necessary for man as for the pine trees. In fact, it is impossible to exaggerate the importance of fresh air which is one of Nature's beneficent gifts to man. It flushes the body with oxygen, stimulates various physiological activities, increases metabolism and braces up the nervous system. Its effects are enhanced by the action of sunlight which purifies the atmosphere by its actinic rays, and both have a stimulating and vitalizing influence on the organism. The absorption of radiant energy of the sun by the body takes place vigorously in outdoor life. Under the influence of fresh air the patients lose their irritability and nervousness; it increases their appetite, lessens fever and promotes sleep. In fact it is food, medicine, and more, all combined.

How can we scientifically explain all the beneficial effects of fresh air on the body metabolism? Are they due to its chemical purity? Are the bad effects of confined atmosphere

due to lack of oxygen or an increase of carbon dioxide? Professor Leonard Hill[2] thinks it does not matter if in the air we breath there is a little more carbon dioxide and a little less oxygen than the normal, that in the worst ventilated room there is not one per cent. less oxygen, that there is no physiological evidence that organic impurities of respiration are toxic, and that discomfort in a closed room is due to heat and moisture and not to carbon dioxide. Dr. M. J. Rosenau[3] also believes that it is the heat stagnation that makes us feel uncomfortable in a badly ventilated room rather than any change in the chemical composition of the air. The New York Commission on Ventilation, which also agrees with the views of the two previous workers, states that when the air is allowed to remain stagnant, and there is no interference with the elimination of heat from the body, there is disturbance of metabolism, decreased working power, and early onset of fatigue. Boycott and Haldane[4] go so far as to say that the feeling of warmth of a rather unpleasant kind is due to the diminution of the alveolar carbon dioxide, and that the rise of CO_2 tension is associated with a general exhilaration and stimulation produced by cold air. As Professor Henderson[5] says we have really no adequate scientific explanation for the health stimulating properties of fresh air. It is difficult to believe that the above theories can adequately explain the striking difference one finds in the patients when they first arrive, pale, ill, and sickly from unhealthy and smoke-laden cities, and after a few weeks' stay in the sanatorium, when they are seen with ruddy cheeks and glowing health. If there is not a difference of one per cent. of oxygen between the inspired and the expired air, and if artificial inhalation of oxygen has no effect on tuberculous lungs, oxygen cannot play a very important part in this striking change in the patients, and the lowered vitality caused by prolonged confinement in close air cannot be entirely due to deficiency of oxygen. With all due deference to the scientific workers we have above quoted, one cannot help asking why a lack of evaporation of heat from the body should cause such decreased efficiency and

metabolism, and the movement of cool, dry air should give tone to the body and increase its metabolism? Evidently there is something in the cool, fresh air which is lacking in the stagnant, humid conditions of the atmosphere. Can it be that fresh air, like fresh vegetables and fresh food, contains some vital thing, some vitamine principle which defies chemical analysis and which the scientists are not aware of? Perhaps the Hindu philosophers are right after all when they assert that besides its chemical constituents the atmospheric air contains a vital universal principle called 'prana,' through which life manifests itself, and the fresher the air the more it is charged with 'prana.' Perhaps 'prana' is the vitamine principle, and the oxygenation of the blood is best secured when oxygen contains this pranic element, and in close, vitiated air the oxygen is deprived of this element and thus of its life-giving power. This may explain why fresh air is so essential to all body activities, and why without it, even for a few moments, life ceases to exist. Whatever be the explanation, all workers are agreed that the open-air treatment is in line with the findings of modern science when it explains that fresh air is essential to health and well-being of man and in the treatment of consumption. Its effects are threefold—physical, physiological, and psychological. It stimulates the activity of body and mind, it lessens irritability, calms the nervous system and promotes healthy metabolism, and thus helps in the arrest of pulmonary tuberculosis.

All the efforts of the sanatorium régime are so directed as to enable the patient to have a constant supply of fresh air day and night. The more thoroughly the patient's life is spent out-of-doors, the more satisfactory is the result. The patient's life is so arranged in the sanatorium that he spends his time in the open air. In the summer he practically lives out-of-doors day and night, merely using his châlet for dressing and his rest; his meals and amusements, and even the Sunday services, are all carried out in the open air. In the winter he spends a great part of the day on the veranda, and even sleeps out there if the weather is favourable. And

open-air life is made as pleasant as possible by games, picnics, tea-parties, and walking excursions which are organized from time to time. The senior patients spend part of their time in open-air camps, and are allowed to go out shooting. The châlets are so built as to allow the fresh air to flush through every part of the room. They are all situated on the ground-floor, and are built two by two, so that each of them is open on three sides. A common corridor runs along the back of the châlets, facing north; and on the south side there are two large French windows, extending from the floor to the ceiling, and leading to a veranda in front, separate for each châlet, and on the same level with the bedroom, so that the bed can be wheeled right out.

(*b*) Rest.

Rest further enhances the beneficial effects of fresh air. It stops all unnecessary leakage and expenditure, and enables the nervous system to get back a healthy control over nutrition and circulation. The modern age has lost the secret of restfulness and has succumbed to the evil of restlessness. But Nature rests everywhere. In the long dark winter she rests from her active labours, and at the same time is passively engaged in storing materials for the wants of summer. When the curtains of the night are drawn across the world, man and all living things seek their rest in sleep and quiet, to recuperate the jaded energies spent in the day's activities. And in conditions of disease, when fever racks the forehead, and the hot blood pulsates through the veins, the child seeks its mother's arms, and the patient his repose in bed. Rest and exercise are twin sisters that make up the sum-total of life. Only rest is the elder sister that closes the weary eyes and soothes life's fret and fever; and exercise is like the laughing stream, or the skipping deer, that gathers strength as it wanders from place to place. Here, in rest, in the open air, the physical and psychic elements of man come very near each other. As the patient rests and communes with Nature, the calm surroundings, the serene landscape, the quiet evening, hush him into silence, and breathe a spirit

of restfulness and peace in his inmost being. In this age of bustle and excitement, when restlessness is bred in the very bone both by heredity and environment, it is becoming more and more necessary that the physician should enjoin rest upon the patient to bring about the healing of the lung.

When a patient first comes into the sanatorium, he is either put to bed for a few days or ordered to rest in the open air during a great part of the day. In all active cases with fever, a rapid pulse, loss of appetite and weight, perfect rest in bed is enjoined, all excitement is avoided, visits and talking are restricted, and physical and mental rest prescribed. The higher the temperature the more the patient rests. And rest is enjoined during the whole of his sojourn in the sanatorium. The junior patients rest more than the seniors, and go to bed earlier. As childhood slumbers early and long, so the patients require longer hours of rest in sleep. The temperature is a rough guide as to the amount of rest to be prescribed to each patient. Absolute rest in bed often helps to bring the temperature down, though in acute disease, where the patient has very little resisting power, it may have no effect.

(*c*) **Exercise, etc.**

Exercise forms a very important part of our daily régime. It is but right to mention here that the writer has given very careful attention to this part of the treatment for many years and has developed it into a system since 1902—long before Frimley sanatorium, under Paterson, brought the matter of graduated exercise before the profession. Looking over the expression of opinion among tuberculosis workers, one finds they are divided into two schools—one school believing with Dettweiler in absolute rest, and the other with Walther in rigorous exercise. It is a mistake to exaggerate the importance of one at the expense of the other.. Each has its legitimate place in the scheme of sanatorium treatment. Consumptive patients require both at the proper time and in the proper dose. It is true that the tendency of the Occident is to take advantage of the views of the second school and

FIG. 16.—PATIENTS SAWING IN THE WORKSHOP.

advocate intensive exercise. Like all good things, both systems can be abused and can have disastrous results. J. H. Pratt,[6] who is an advocate of prolonged rest, draws attention to the fact that many, if not most, of the sanatorium patients at Frimley do five hours of hard work daily before leaving the sanatorium, and after returning to work a large number of them break down within the first two years, and that this may account for the rapid falling off of well and working patients from 100 per cent. at the beginning to 62 per cent. at the end of one year, and to 50 per cent. at the end of two years. From our own experience we would say that five hours of hard work daily is rather a laborious exercise for a consumptive patient undergoing sanatorium treatment. We know of another sanatorium where, no doubt influenced by the Frimley example, both male and female patients were put to do three to four hours hard work daily, with the result that some of them broke down and had to seek other institutions to repair the mischief done by such strenuous exercise. On the other hand, intensive rest treatment has also its disadvantages. Patients treated with prolonged rest after some time get tired and listless, their spirits droop, and they are unable to take an interest in life; their appetite fails, their muscles get flabby, and their powers of resistance are lowered. These symptoms are rather danger signals, indicating that prolonged rest is doing them harm. The truth is that the treatment by rest and exercise, at present developed into a science, should only be undertaken by a physician who is well experienced in every phase of the disease and the condition and temperament of each patient. Nowhere is the skill and ability of the sanatorium physician tested so keenly as in the manner in which he regulates the amount of rest and exercise requisite to each patient. It can be laid down as a general rule that the patient should rest when he has a temperature—the higher the fever, the more absolute the rest—and that when the temperature comes down to normal, exercise should be begun. But this rule needs some qualifications, and it is only by long experience that the physician is able to know how to deal with

each patient. In some cases, where there is a great deal of fatigue and exhaustion, rest should be prescribed even when the temperature is normal. In some chronic cases a little exercise acts beneficially, even where a slight temperature and extent of lesion seem to contra-indicate it.

Rationale of Exercise.—Exercise, like rest, has its physiological and psychological effect. It increases the intake of oxygen, stimulates the physiological activities of various organs which under prolonged rest may become inactive and fail to function, determines more blood to diseased parts, and creates a healthy reaction which is so necessary in the healing of the lung. Further, the most striking effects of exercise are an increase of force in muscles, of energy, and velocity, the removal of fatigue-products, the development of sinews and bones which get firmer, tougher, and stronger, and greater contractility of muscles, and greater tone and conductivity of nerves and will power. Besides, it keeps the mind of the patients occupied. The knowledge that they are put to do some work cheers and brightens their spirits, they think they are on the road to getting well, and they feel contented. Thus exercise forms a part of their psychic treatment.

The exercises carried out in our sanatorium come under five headings: (1) Walking exercises; (2) graduated exercises; (3) breathing exercises; (4) singing exercises; (5) camping, tramping, etc.

(1) **Walking Exercises.**—When the patient's temperature is normal, or approaches it if it has been high, he commences to take walks, beginning from half a mile, gradually increasing to six or eight miles a day. If the temperature is normal in the morning and rises in the evening, he is allowed a little walk in the morning, and rests during the remaining part of the day. There is no hard-and-fast rule applied to all patients alike. The physician daily supervises the walk of every patient. If the patient has been in the sanatorium for some months, and kept in bed more or less all the time because the fever has been continuous or inclined to go up in the evening, then it becomes a question of choosing one of

FIG. 17.—PATIENTS PLANING IN THE WORKSHOP.

two evils: absolute rest in bed, causing the patient to get dull and tired of monotony, his muscles flabby, the digestion poor, and the nights restless; or relaxing the general rule, and varying a part of his programme in spite of his fever. The latter seems the lesser of the two evils, as we have found from experience that some of these patients are better for sitting up in bed, or for a little walk in the morning, or a small drive, etc.—any change like this tending to break the monotony and to add a new interest to life, and help appetite and digestion. But as the temperature becomes normal and the patient improves, he is slowly and gradually promoted till he does the full time of about three hours of walk a day—an hour and a half in the morning, an hour in the evening, and a short walk before breakfast and after supper—when he covers about six to eight miles during that time.

2. **Graduated Manual Exercises.**—Walking prepares the patient for graduated exercises. When his temperature and pulse are more or less normal and he is otherwise in a satisfactory condition he is allowed to do some manual work. To begin with, he is put on the first grade when he works for five or ten minutes in the morning; and as he improves, the time is extended to twenty minutes in the second grade, thirty minutes in the third grade, and forty minutes or more in the fourth grade.

First grade: 5 to 10 minutes.—Weeding in the garden, hoeing, raking, and gathering fallen leaves, etc., and if weather is unsuitable for outdoor work he chops small sticks in the workshop.

Second grade: 10 to 20 minutes.—Gardening, raking, pruning, clearing and making paths in the woods, or chopping if the weather is unfavourable.

Third grade: 20 to 30 minutes.—Sawing wood, lawn mowing, edging grass, gathering fallen leaves into the wheelbarrow, clearing broken ground, levelling paths with rakes, etc.

Fourth grade: 30 to 40 minutes or more.—Sawing and planing wood, light carpentering and painting, and wheelbarrow work, digging, lawn mowing, rolling, etc.

The work is constantly changed. The secret of graduated work is not to let it become monotonous or mechanical, but to vary it according to the weather and the patients' idiosyncrasies and inclinations, and to treat patients not as machines to get a certain amount and certain kind of work out of them, but as human beings who take an intelligent interest in what they do, and vary their work so that they can get the full benefit of all the exercises.

About the end of the second period of sanatorium life the patients have about forty minutes to an hour of manual work, and in the convalescent period they are allowed to do any congenial work for about two hours which is our time limit. This with breathing, singing exercises, etc., we consider quite sufficient to obtain the full physiological benefit of labour. Sometimes when the weather is fine the patients leave off doing any manual work, but go for a long walk or make up a party to go for an excursion, etc. Thus there is no set task or rigid discipline in the life of the patient, especially as he comes near the end of the second or the beginning of the convalescent period. Graduated exercises are, no doubt, an important therapeutic measure, and applied intelligently and in selected cases would further the arrest of the disease. It is not clear how they act beneficially. Paterson's[7] theory that they induce auto-inoculation presupposes that auto-inoculations are caused by the patient's own bacterial products getting into the blood stream and causing fever. But we have no evidence that fever is caused by bacterial products. Biochemistry suggests that symptoms of fever are rather due to chemical changes and are not necessarily bacterial. Besides, auto-inoculations do not always cause constitutional disturbance. Many a patient with active disease does not run a temperature, and even hard work does not always provoke a fever. Further, the studies of Barnes,[8] of the Rhode Island Sanatorium, America, indicate that mild febrile auto-inoculations are injurious rather than beneficial. He found that the fewer the fever days the better the chance of the patient's recovery, and he made the important observation that patients who had occasional auto-

inoculations relapsed more frequently than those who had no periods of fever while under treatment. The more reasonable explanation of the benefit of exercise is that it brings more fresh blood and increased activity round the part affected. This is Nature's way of healing by hyperæmia, which need not necessarily be accompanied by fever. As we do not know if there is any relation between auto-inoculations and the protective mechanism of the blood, the physician should not be tempted to push on exercise with the belief that intoxication phenomena will be followed by immunizing responses as Paterson believes. On the whole, the danger of over-exertion may be said to be greater than that of excessive rest.

3. **Breathing Exercises.**—After walking and graduated labour come the various breathing and singing exercises. By this time we assume that the patient is in about the middle of the second period, his temperature is normal, and the disease is more or less quiescent. These respiratory exercises, so far as the sanatorium is concerned, have for their object not so much the development of the muscles of the body as the development of correct breathing and expansion of the chest; therefore ordinary calisthenics, Swedish drill, and athletic exercises with dumb-bells or Indian clubs, etc., as practised in schools or in gymnasia, have no place in our sanatorium. Ours are medical exercises, carried out under the supervision of the physician, according to the condition of the patient, who is forbidden to take part in any of them if the temperature is high, if he has any active disease, or his health is in any way considered unsatisfactory. While our main object is to improve the expansion of the lungs, the whole body derives benefit by increased oxidation and circulation, and improved well-being.

Preliminaries.—The patient, in the open air, stands erect, his legs and thighs pressed together and rigid, the hands down, with the palms against the legs, the shoulders thrown back, the chin slightly up, and the lips closed.

No. 1 *Exercise.*—(*a*) The patient, as he slowly extends the arms to a horizontal position, takes a deep inspiration,

retains the breath at this position for two or three seconds, then brings the arms down to the sides, expiring the air at the same time through the nostrils. The breathing-in should correspond to the extension of the arms, and breathing-out when the arms are brought to the sides. This is repeated six times, with an interval of three or four seconds between each repetition.

(*b*) The same as above, but the heels are raised with the extension of the arms and inspiration, and are brought down during expiration.

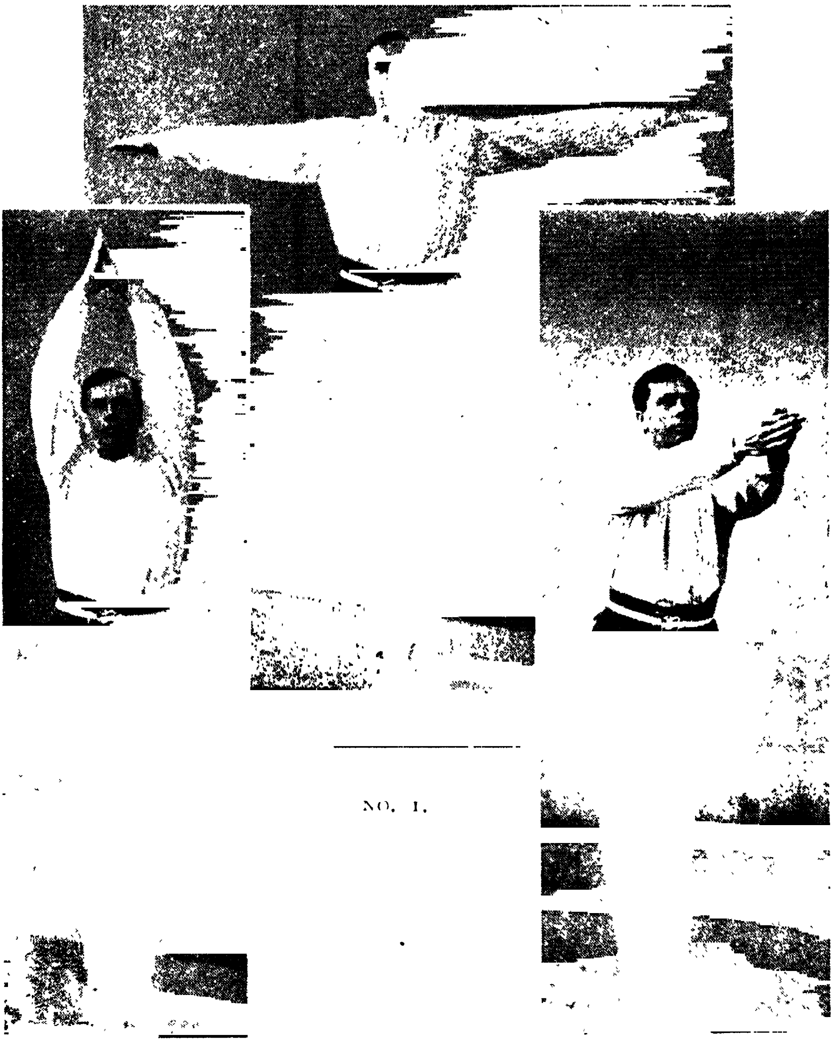
No. 2 Exercise.—(*a*) With the preliminaries of the first exercise, the arms are raised over the head during inspiration till the palms of the hands meet, the patient expanding the chest and taking in deep breath all the time; and after a second or two, the palms turned outwards, the arms are slowly brought down to the sides during expiration. This is repeated six times.

(*b*) Here, while the arms are coming down and the patient is slowly exhaling, he bends forward, presses the elbows to the sides, and squeezes the sides of the chest and the diaphragm against the lungs. This is repeated six times.

No. 3 Exercise.—(*a*) The head erect, the heels together, the arms flexed, the palms of the hands pressed to the sides, the fingers pointing inwards, the arms are swung forwards as far as they will go, as in the act of swimming, the patient breathing deeply through the nose, and then the arms are brought to the sides during expiration.

(*b*) A bigger sweep of movement is given by bringing one of the legs forward, and, while bending the body forwards, the arms are stretched, as in the act of swimming, and the exercise finished as in the first part of the exercise. This is repeated three times. Then the other leg is brought forward, and the exercise repeated another three times.

No. 4 Exercise.—Deep breathing. This is one of the commonest exercises practised by the ancient Yogis, who believed that correct breathing tended to prevent disease and lengthen life. Although this exercise is divided into



NO. 1.

NO. 2.

NO. 3.

FIG. 18.—PHYSICAL EXERCISES.

To face page 240.

three parts, bringing into play first the lower part of the lung and the diaphragm, then the middle, then the upper part of the lung, it is one long, continuous breathing, which expands the whole, from the bottom to the top of the chest cavity. The patient, sitting or standing erect, breathes through the nose, and, without any jerk, inhales steadily, first filling the lower part of the lung, pushing forward the front walls of the abdomen; then he fills the middle part, pushing out the lower ribs; then the upper part of the lung, lifting the chest and upper ribs; and at the end of inhalation he throws the head back, elevates the shoulders, and raises the collar-bones, and at the same time draws in the abdomen a little, which helps to fill the apices. Then the patient retains the breath for a few seconds, and exhales slowly from above downwards. When all the air is expired, he relaxes the chest and abdomen, to begin the whole exercise over again. This exercise can be practised during the silence hour, or any other part of the day.[9]

The first three exercises takes about ten to fifteen minutes twice a day. They are not performed if there is any indication of fever or any active signs of disease. When a patient's temperature is normal and the disease is quiescent, he begins with the first, and gradually goes on to the second, and then to the third exercise. If he comes under treatment in the early stage, he is rapidly promoted to all of them. Deep breathing is practised for ten minutes twice a day during the convalescent period. The patient begins by taking three to four deep breaths a minute for two or three minutes the first day, and increases a minute every day till he reaches the ten minutes.

We find that these various exercises, properly performed, while they teach the patient the art of correct breathing, expand the chest, develop the muscles of the trunk, dilate the air-vesicles and increase the lung capacity, and, by the simultaneous contraction of antagonistic muscles, produce symmetry of body, correcting any small deformity or abnormality, so prevalent among consumptive patients. Physiologically, they quicken the respiratory functions, accelerate

16

the flow of blood, stimulate the hepatic secretion, regulate a healthy metabolism, and improve the general health.

Deep breathing does more. The respiratory movements have a very important effect on the circulation of the blood.[10] During deep inspiration the thoracic pressure is diminished and abdominal pressure is increased, the blood from the abdominal cavity and the brain flows into the thorax, the lungs distend, the bloodvessels get enlarged, causing a state of hyperæmia, the lymph flow in the thoracic duct is accelerated, a greater quantity of oxygen is absorbed, and a greater quantity of carbon dioxide is given off than during ordinary breathing, bringing about a more rapid gaseous exchange both in the lungs and in the blood. During deep expiration the thoracic pressure increases and abdominal pressure decreases, the abdominal muscles contract in all directions and press upon the nerves and upon the bloodvessels of the liver, the spleen, the pancreas, stomach, and intestines, and the blood that is drawn into the thorax during deep inspiration flows back again with great speed.[11] Thus, deep breathing quickens the circulation, stimulates the functions of all the thoracic and digestive organs, and invigorates the tissues and strengthens the whole body.

4. **Singing Exercises.**—These also form an important part of deep breathing and share all its advantages. They invoke correct nasal breathing, maintain a better expansion of the chest and a freer passage of air to remote parts of the lung, such as the apices—which are liable to become tuberculous owing to their comparative inactivity—and determine a more efficient supply of blood to these parts, and thus indirectly improve the local and general health.

(*a*) The patients sing 'ah' to the first six notes up the scale, beginning from the middle *c*, and then down, taking as long a breath as possible with every note.

(*b*) Then they go on to sing 'ah' to the first four notes up the scale at one breath, and down the scale at another breath. The four are gradually increased to six and then to eight notes up the scale at one breath, and down at another breath.

(*c*) After this, the four notes of the chimes are sung at one breath, then eight notes at one breath.

(*d*) Then they learn to sing simple musical pieces on 'ah,' the whole of the singing taking about ten to twelve minutes, morning and evening.

Barth,[12] of Koslin, has made a thorough study of the effects of singing on the action of the lungs and heart, on the vocal apparatus, the development of the chest, in metabolism, and in the activity of the digestive organs, and has come to the conclusion that singing is one of the exercises most conducive to health.

The breathing exercises, if correctly performed, not only improve the thoracic movement of the chest, but also increase the diaphragmatic breathing.

I quite agree with Dr. Halls Dally[13] that the measurement of the chest expansion is no index of thoracic respiratory capacity or pulmonary mobility. The movement of the pulmonary apices is more influenced, and freer access of air is better secured by the costal or diaphragmatic than the thoracic breathing. Too much stress has been laid hitherto on the chest expansion, and very little upon the up-and-down movement of the lung. The diaphragm plays a very important part in respiration, and its limited movement very often indicates early disease of the lung. Hence it is essential that the diaphragmatic breathing should be specially developed in pulmonary tuberculosis as soon as the disease is in a quiescent state. As the patient improves, the free movement of the diaphragm is more or less restored by the breathing exercises.

Ever since manual labour was introduced in this sanatorium as part of the treatment a decided improvement has been noticeable. During an experience of more than eighteen years we have had no untoward result except in two instances, when the temperature rose after the exercise and continued for some days after, which showed that the patients had over-exerted themselves (see Fig. 19).

The temperature, as in the case of rest, is a rough guide to the physician as to the amount of exercise he should pre-

scribe. I do not think that a rise of temperature to 99° F., or even to 99·4° F., is necessarily a contra-indication to work. On the other hand, I am of opinion that a small rise is often a sign of a healthy reaction, and an indication that Nature is working to bring about an arrest of the disease. Symptoms of fatigue, headache, high temperature and pulse after exercise are an indication that the patient should cut short the duration and character of his labour. In chronic cases with a persistent temperature we often find it advantageous to let the patient go for a short walk after breakfast and rest the whole of the day. In this way—a little exercise in the morning and plenty of rest afterwards—we were able

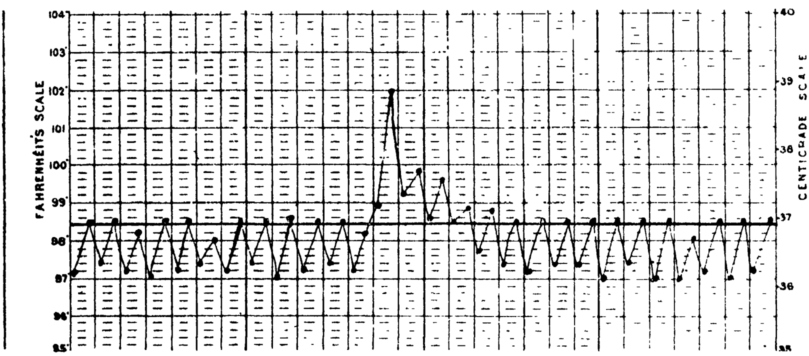


FIG. 19.—SHOWS THE EFFECT OF MANUAL EXERCISE ON THE TEMPERATURE OF A SENIOR PATIENT (P. 243).

to bring down the temperature in many cases. Each patient requires individual attention and treatment.

5. **Camping, Tramping, etc.**—By the time the patients reach the convalescent period they instinctively desire a wider scope and greater activity to give exercise to their returning health. Therefore we saw the necessity of introducing a system of tramping tours during the last stage of the patients' stay in the sanatorium as a means of giving a final touch to the cure of their disease. And the result has been eminently satisfactory. By taking the patients to 'fresh fields and pastures new,' a new interest has been created which gave fresh stimulus to the healing energies to bring about the final arrest of the disease.

FIG. 20.—PATIENTS SAWING IN THE WOODS.

FIG. 21.—PATIENT PLANING AND CARPENTERING.

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FIG. 22.—PATIENTS CAMPING OUT.

To face page 244.

By the time the patients begin their extended walks and tours, we assume they have passed the preliminary stages of sanatorium treatment and gone through all the graduated exercises one by one ; their temperature has become normal, and their cough and expectoration have nearly if not altogether ceased, and their resisting powers are greatly improved. It is then safe to introduce them to the programme in this fifth division. Some senior patients are allowed to shoot. The patient, with a gun in his hand, tramps many miles in search of game. The writer is convinced that long, steady walking, without feeling fatigue, especially walking with an object in view, is one of the most healthy exercises for a consumptive patient ; it stimulates all his bodily functions and he comes back in a healthy glow. On other occasions the senior patients are allowed to camp out on some part of the estate, cook their own breakfast, and come down to the sanatorium for other meals. The camp life is extended to tramping tours. Judicious tramping is one of the important means in the hands of the sanatorium physician for the restoration of a diseased lung. As a preliminary to long tramping, patients go for half a day excursion, preferably in the afternoon. They leave the sanatorium about two o'clock in the afternoon and do not return till six, which is their rest hour before supper. Thus they do about five to six miles in the course of their walk, visiting any place of interest that lies within that area. These afternoon excursions are gradually extended to embrace the whole of the day, when, with arrangements to have luncheon and tea on the road, the patients go further afield, and after a tramp of ten to twelve miles return in the evening in time for the rest hour.

It is very necessary that the sanatorium physician or some one responsible should take charge of the walking tours, for the programme of the day might require cutting short or lengthening, according to the weather or other circumstances ; a halt might be found advantageous to visit a neighbouring place of interest. In the next stage, the patients are allowed to go for two or three days' excursion

when they walk about ten to twelve miles a day, sleep the night in a wayside inn and resume their journey the next morning, and after walking another ten or twelve miles a day return by train to the sanatorium.

Lastly, tramping leads to caravan tours, the development of which at the sanatorium was unfortunately cut short by the great war, but which we hope to put into operation at the very first opportunity. The idea is that patients on these tours go still further afield, and after tramping for three or four days in the open country and living a simple life, return to the sanatorium.

What a change this tramping life would bring to the town-bred patient. The rosy flush of the early dawn, the morning chant of the birds, the sunlit fields and meadows fill him with new delights; while the afterglow of the sunset, the hush of the twilight, the radiance of the starlit sky calm his mind and still his soul into quietness and peace. And as he lies down to rest he nestles close to the bosom of mother Nature and lets her wrap him in dreamless sleep.

These walking tours have a great therapeutic effect on the body: they bring every muscle into play, promote deep breathing, increase the circulation of the blood, stimulate the healthy activity of every organ of the body, and help in the final arrest of the disease. We can speak from experience that tramping tours in the country under open-air conditions, and carefully conducted and supervised by the physician, offer an unlimited scope of usefulness in the sanatorium régime of pulmonary tuberculosis. In fact, every one of the exercises briefly sketched here, which are carried out in our sanatorium, plays a definite part in enabling the patient to work out his salvation with the help and guidance of the sanatorium physician.

REFERENCES.

[1] Dangers in Neck Wear, by Walford.

[2] Professor Leonard Hill, *Journal American Medical Association*, April 8, 1911.

[3] Rosenau, *Boston Medical and Surgical Journal*, November 6, 1913.

FIG. 23.—PATIENTS ON A TRAMPING TOUR.

To face page 246.

[4] Boycott and Haldane, 'The Effects of Low Atmospheric Pressure on Respiration,' *Journal of Physiology*, 1908, vol. xxxvii., p. 359.

[5] Professor Henderson, Atmospheric Air in Relation to Tuberculosis, by Guy Hinsdale.

[6], [8] Pratt, 'The Importance of Prolonged Bed Rest in the Treatment of Pulmonary Tuberculosis,' *American Review of Tuberculosis*, 1918, vol. ii., p. 637.

[7] Marcus Paterson, Auto-inoculation in Pulmonary Tuberculosis.

[9] Pulmonary Tuberculosis and Sanatorium Treatment, by C. Muthu.

[10] 'The Relations of Physical Proportions to General Health,' by Warnshuis, *Modern Medicine*, January, 1921, p. 39.

[11] The Science and Art of Deep Breathing, by Otabe.

[12] Atmospheric Air in Relation to Tuberculosis, by Hinsdale.

[13] Dally, *British Medical Journal*, August 29, 1908.

CHAPTER XVI

DIET IN THE TREATMENT OF TUBERCULOSIS

'Hear this of me! there is a food which brings
Force, substance, strength, and health, and joy to live,
Being well-seasoned, cordial, comforting,
The "Soothfast" meat. And there be foods which bring
Aches and unrests, and burning blood, and grief,
Being too biting, heating, salt, and sharp,
And therefore craved by too strong appetite.'

SIR EDWIN ARNOLD: *The Song Celestial—Mahabharatha.*

TUBERCULOSIS, as we have already seen, is chiefly associated with disordered nutrition and disturbed metabolism. The digestive organs are the first to suffer from civilized life. These two considerations give very much importance to the study of diet in consumption. Our ideas of the nutritive value of food have undergone considerable revision, if not revolution, in recent times. The researches of biochemistry have shifted our attention from the invisible microbes to invisible vitamines found in food. We no longer calculate the importance of food from its nitrogenous or its caloric value, which was insisted upon by the old physiologists. Chemical analysis does not always indicate the dietetic value of food. The old universal estimation of 120 grammes of protein as the basis for the dietary of a working man is not accepted at the present day. Chittenden regards Voit's standard of even 100 grammes as fixed too high, and reduces the quantity by half, to 60 grammes, while Professor Cohnheim, Caspari, and Loewy argue that a fully grown-up man requires at least 80 grammes.[1] The efficacy of the protein supply cannot be reckoned even by its amount, since proteins of the same quantity differ in their quality, their nutritive

value, and their power of digestibility. As a matter of fact, the food supply of an animal may contain protein and energy in sufficient amount and yet may fail altogether to support it.[2] Also, it has been proved by most careful experiments with young animals that a given weight of protein (casein) of milk will produce more flesh than the same weight of protein of grain, peas, or other vegetable product.[3] Dr. Hindhede[4] considers that Voit is erroneous with regard to his theories of protein requirements in man's dietary, and has shown from his experiments in human beings at his laboratory at Copenhagen that man can perform heavy work and remain in good health, even gain in weight, on a diet of potatoes and bread with the addition of fat, provided that the bread is made of good wholemeal and the potatoes are not peeled before cooking, and thus deprived of their potassium and vitamine content. His experiments on Europeans seem to corroborate what we find in the East, where Indians, the Chinese, and the Japanese labourers do a hard day's work on brown and unpolished rice and vegetables. So that it is time we recognized that the nutritive value of food cannot be estimated by its composition or its energy value as taught by the older physiologists. In theory the value of food may be calculated in grammes and calories, but in everyday experience it depends, among other factors, upon—

1. The physical and vitamine properties of the foodstuffs.
2. The digestive capacity and the mental attitude of the individual.

Mention has already been made (see Chapter VIII.) of a series of biological experiments made on foodstuffs with a view to finding out their digestive and nutritive values. Among many interesting observations made as the result of these experiments, the following can be cited here: The chemical analysis of foodstuffs differed according as they were fresh or stale, green or dry, when they were tested or taken into the stomach. Fruit, sun-ripened on the tree, proved to be more assimilable than when it was artificially ripened, after being picked in a green condition. Also, fruit

is more easily digested when eaten fresh in the morning on an empty stomach than when cooked and eaten with sugar, and with or without other foods. Fish cooked after being recently caught was digested in from three-quarters to one and a half hours, giving a good percentage of phospho-proteid, phosphorus, and traces of salts of sodium, barium, lithium, magnesium, etc., but no appreciable quantities of purin. Raw dead fish diminished in phosphorus and essential salts in proportion to the time elapsed from cessation of life to the time of testing. Twelve hours after death no appreciable quantity of phosphorus remained, and twenty-four hours after no traces could be found, but the quantity of purin formed increased in proportion. Freshly-drawn milk, when taken on an empty stomach—*i.e.*, two hours after or half an hour before a meal—was easily digested when mixed with alkaline saliva. Raw eggs showed quick assimilation—the fresher the egg the more rapid the digestion and the less the quantity of purin formation. Meat in a raw or semi-cooked condition was more quickly digested, and gave less purin than when completely cooked or stale. Vegetables and bread and other starchy foods eaten with the meat did not seem in any way to impede its digestion. Meat taken with milk gave the worst results, causing retardation of digestion and production of purin. Fruit and vegetables when picked fresh retained for a considerable time their essential salts, such as phosphorus, iron, magnesium, etc., and certain vital qualities that defy analysis, but which altered or totally disappeared when they became stale. The mixture of fresh egg and raw milk or of cheese, green vegetables and wholemeal bread, gave good results, but a combination of milk, bread, and raw fruit or cheese and milk, gave unsatisfactory results. Nuts, grains, and pulses, when deprived of their germ, ground up and exposed to the atmosphere, lost their vitality and the greater part of their essential salts, and their starch became incapable of assimilation under the action of gastric juices.

So that one great lesson we gather from these experiments is, that the physical properties of foodstuffs play a more

important part in the process of metabolism than their actual chemical properties—the fresher the food the more easy and rapid the digestion, and the more nutritive its value—because fresh and alive foods retain their electric potential which ensures their full enzyme and vitamine content and rapid digestion and absorption. On the other hand, stale and boiled foods, canned and frozen foods, are largely deprived of their electrical and enzyme properties which render digestion slow and difficult, and open the door to many alimentary disorders. If, therefore, health and disease processes chiefly depend in the first place upon what we eat and drink, the study of the food question, its selection and preparation, ought to engage the serious attention of both the physician and the patient. By a carefully chosen diet we can help Nature to replenish and renovate our bodies in the cure of disease. Even toxins and virulent bacilli in the system can be rendered harmless by a change of diet from meat to one of vegetables, fruit, salads, etc.

The laws of health are very simple, and can be mastered by anyone willing to learn. After fresh air, rest, and exercise, the diet of the patient should receive careful attention. All foods should be of the best quality, plain and varied, not over-stimulating, properly cooked, and daintily served. Meals at regular intervals, slow mastication, rest before principal meals, a calm mind and cheerful temperament before and during eating help to promote digestion and health.

Following the teaching of the old school, which insisted on high protein requirements, the Western nations, no doubt, consume a larger amount of food, especially meat, than is physiologically necessary or compatible with health. It has been proved that diets containing 3,767 calories (overfeeding) did not give so good a result as the diet containing 2,928 calories.[6] Inefficiency and disease can be brought about both by poverty and plenty, by overeating and underfeeding. Many digestive disorders arise from the incompatibility of food taken. Meat taken with strong tea or with a large quantity of milk, or meat with starchy foods or with fruit, milk and sugar, etc., are all combinations which in course of

time create digestive trouble especially in the dyspeptic. The vegetarians have done good service in calling attention to the importance of fresh green food in the everyday dietary. Salads, fruit, and vegetables are necessary for the body, because they contain anti-toxins as Knaggs[6] calls them. Fresh fruit, green foods, and salad vegetables have a cooling and cleansing effect on the system, besides supplying the natural alkaline salts for the blood and for neutralizing the acids formed during digestion. While fresh fruit and vegetables are rich in potassium salts, sodium salts are chiefly found in animal foods. Potatoes should be cooked with the skins as the Irish do, as peeling removes most valuable ingredients, such as potassium, found immediately under the skin; 30 per cent. of salts and mineral matter are extracted and lost when vegetables are boiled and only 10 per cent. when they are steamed; hence they should be steamed and stewed in a casserole or covered earthen vessel so popular in France, and the boiled water, if any, should be saved for making soups and sauces. A good proportion of uncooked foods is rich in phosphorus which supplies the nerves to build up their lecithin, while the process of cooking, and indigestion associated with putrefaction or fermentation tend to convert the organic phosphorus into inorganic salts which cannot be assimilated by the system.[7] The baker's bread is of poor quality compared to the home-made article (made from finely ground wholemeal), because the flour from which it is made is deprived of the germ and outer layers of the wheat grain which contain fat, organic phosphorus, mineral matter, enzymes, and amino acids, which are essential to digestion and health. Margarine made of vegetable fats is a poor substitute for butter, and is largely, if not wholly, deprived of the vitamine fat soluble A, which is most abundant in butter and cod-liver oil. Therefore the use of margarine in a sanatorium ought to be condemned. Tea and coffee have practically no food value and are useful only for their flavouring and stimulating properties. It is reckoned that a cupful of Indian tea of ordinary strength infused for five minutes contains about 1 grain of theine or

caffeine and twice or three times as much tannic acid, which is apt to interfere with the conversion of starch into sugar by the saliva and with the digestion of meat in the stomach. China tea is poorer in tannic acid and less apt to cause acidity, and, therefore, should be preferred to Indian tea. Cheap sugar and tea, as the *British Medical Journal*[8] says, have done disservice to our people. No wonder that the diet of the lower classes, which is chiefly made up of white bread, strong tea, margarine, and canned meat, is not only of poor nutritive value, but leads in the long run to gastric disorders, malnutrition, and disease like tuberculosis. Fruit is one of the best stimulants of the saliva, and prevents oral acidity and dental caries. Fresh and juicy fruits and salads keep the blood cool, the digestive tract clean, and the body wholesome. Cheese has a high value as a tissue-repairing and body-building food, and in combination with bread and butter and salad makes a perfect meal.

Diet in Pulmonary Tuberculosis.—When the sanatorium treatment was first inaugurated in England, some twenty-five years ago, the treatment of consumption was understood to consist mainly of fresh air and hyperalimentation. The medical profession then was so much impressed with the 'Nordrach system' of feeding that the patients were commonly advised to eat as much food, take as much butter, and drink as much milk as they could, and the sanatorium patients were also stuffed with platefuls of meat and pints of milk. The consequence of this indiscriminate feeding was that when the patients did get well they became chronic sufferers from dyspepsia and other gastric derangements. Now years of practical experience have taught us to use more discretion and discrimination in the diet of tuberculous patients, with better and more satisfactory results. Generally speaking, consumptive patients in the early and curable stage do not require more food than others. When there is a great deal of emaciation, patients should be encouraged to eat more. If they cannot, the condition of the stomach should be looked into and any error rectified. As a rule the open-air treatment, together with the regular life led in the

sanatorium, creates a healthy appetite, which requires no compulsion or encouragement. It is impossible to formulate a standard diet suitable to all tuberculous patients, as they differ in age, sex, temperament, height and weight, in the condition of their disease, in their digestive capacity, etc.

During the first part of the patient's life in the sanatorium the change of air and environment and rest give him a good appetite. In the middle part of his stay, various exercises, such as walking, breathing, and graduated labour, together with the regular hours of rest, keep up his powers of digestion, while during the remainder of his stay various means, such as walking, tramping, and camping, induce a natural appetite if it shows any signs of slackening. For instance, there are three senior patients who have been camping out in the sanatorium grounds for the last three or four weeks. Though they had hitherto kept up their weight more or less, their appetite somewhat began to fail; but as soon as they took to camping (which means sleeping in the camp, cooking their own breakfast, etc.), they began to improve in appearance, in appetite and weight, one patient gaining three pounds in one week. So that the great secret of dieting sanatorium patients lies in using every natural means to create a healthy appetite and, if possible, seeking no artificial aids in the way of medicine or patent or concentrated foods.

I believe in the three-meal system. Dr. Walther, of parent Nordrach, showed his wisdom in not allowing more than three meals a day. The stomach is the greatest friend of the consumptive, and the physician, like a wise general, prepares for future eventualities and does not put too much strain on it, but reserves all its energy and economizes all its resources for the coming campaign. Hence the gastric organs should have four hours' rest between meals and, generally speaking, no food should be given between breakfast, dinner, and supper. A cup of tea (with just one thin piece of bread and butter) at four in the afternoon cannot be considered a meal; it rather helps to carry on the digestion of the midday lunch; only it should not be converted into a regular meal by the addition of pastry, cakes, jam, etc. The more rest given to the di-

gestive organs, the better and more efficiently will they serve the patient. In fact, I believe that the prognosis of pulmonary tuberculosis depends to a great extent upon the efficiency of the stomach. If it fails for good, not all the artificial and concentrated foods will save the patient's life. Overfeeding is both unscientific and injurious. It is a great mistake to force patients to eat more than they are able. The disgusting habit of making a patient eat again after he had been sick is no better than the practice of the Cæsars, who had recourse to the vomitarium before they took another meal, and is, happily, dying out. While the physician should keep a watchful eye over those who take more food and those who take less than they need, in the majority of cases he should be guided both by his own judgment and by the patient's appetite. The nearer the normal health of the patient the more safely his appetite can be taken as a guide. Forced feeding is not necessary in the early stages of the disease, and is not of much use in the late stages when the stomach is too enfeebled to digest any food. It is founded on an erroneous idea that the more food taken into the stomach the more it nourishes the system. The public are apt to forget that not the quantity of food taken, but the efficiency of the gastric organs to digest and assimilate, is the real criterion to go by. Continuous high feeding has been a fruitful source of trouble in the lives of the patients both in the sanatorium and after. The gain of weight does not always indicate that the disease is conquered. In some fat patients tuberculosis runs an acute course. In the early sanatorium days the cure of consumption went more by weight than by its quality, and sanatorium physicians were eager to turn out as many fat and corpulent patients as possible. But now, thanks to common sense, more rational ideas prevail in regard to diet, though the old notion of stuffing has not yet died out. The stuffing system is a product from the Continent, where also the physicians have seen its evil effects and are warning the profession against it. Professor Labbe,[9] physician to the Paris hospitals, mentions cases of dyspepsia, gastro-enteritis, hepatic congestion, albuminuria, and prolonged fever as resulting from

hyperalimentation. Dr. Mousseaux[10] reports several cases of tuberculosis, 'in which, after improvement had followed a course of high feeding, the patients were obliged to go to Contrexéville in consequence of attacks of renal colic, with the expulsion of gravel or calculi.' Professor Robin,[11] in a patient who took large quantities of raw meat, eggs, and ham, found an increase in the excretion of uric acid amounting to 40 grains a day, followed by pyelitis, the inflammation of the urinary tract only ceasing when overfeeding was discontinued. In my own experience excessive feeding induces dyspepsia, hæmoptysis, dilatation of the stomach, and gastro-intestinal disturbances. I have a patient who, as soon as he is put on the ordinary full diet (which is more than he is used to at home), gets an attack of hæmoptysis which ceases as long as he is kept on a low diet, only to return again when he indulges in his appetite. Shakespeare shows a profound knowledge of human nature when he makes his characters say:

> 'I am a great eater of beef, and I believe that does harm to my wit,'[12]

and

> 'And with our surfeiting and wanton hours
> Have brought ourselves into a burning fever,
> And we must bleed for it.'[13]

Contrary to the ordinary experience I find that excessive meat diet feeds the disease, induces intestinal auto-intoxication, keeps up the temperature, and retards the arrest of tuberculosis. Experiments of Dr. Palier[14] of New York and others have shown that putrefactive and fermentative products of flesh foods render the intestinal saprophytic organisms poisonous and virulent. Appendicitis is practically unknown in countries where vegetarian dietary is the rule.

Sabourin,[15] the director of the sanatorium at Durtol, asserts that nearly all expectorations of blood are of a dietetic origin, and adds: 'To-day, fortunately, the eyes of the doctors are being opened to the disasters resulting on the overfeeding of the tuberculous, but the unadvised public still give way, automatically, by mental contagion, to this habit.'

Guinard,[16] the distinguished director of the sanatorium at Bligny, expressed his protest at the Tuberculosis Congress in 1905, as follows:

'Feeding up, submission to an abundant and varied dietary, that is the simple formula we accept and so often impose upon the tuberculous. It is a false and dangerous formula, let me hasten to say, for the patients, blinded by their anxiety to obtain the maximum of nourishment, make extraordinary efforts to consume food; one sees them, in addition to vegetables, meat, and the usual dishes, gulping down raw eggs, raw meat, milk, meat extracts, and so on. Only one thing is forgotten—the stomach, condemned to a task sometimes far beyond its strength.'

A furred tongue, a bad taste in the mouth, constipation, headache, with slight pyrexia and sleeplessness, are symptoms that the patient is having more to eat than he can digest, and his diet should be cut short.

Especially patients with weak digestion should not be overfed. If after a few days' trial ordinary meals produce fulness and discomfort, the food should be cut short and the stomach given rest. If still the powers of digestion fail, the liquids should be lessened in quantity or cut off altogether during meals, making the food as dry as possible, only allowing a little milk after meals and making the patient rest on the bed before and after a meal. If dyspepsia or anorexia still continues, it is a good plan to try two meals a day. If the stomach is deranged, is it not common sense to give it less work? Here comes the *rationale* of fasting now and then. So thoroughly did the Brahmins and other ancients believe in giving physiological rest that they exalted the fast into a religious observance so that it could be enjoined and made binding upon the people. I have found over and over again that patients who cannot eat are all the better for abstaining from food now and then, as their appetite returns after a while and they are able to relish their food after the fast. In fact, fasting is a leaf taken from Nature's book. If a horse or a dog is ill it will not eat, and man is the only irrational creature that violates Nature's

laws and works the stomach when it is feeble and out of sorts, requiring care and consideration.

The following is the ordinary diet at the sanatorium:

Breakfast, 9 a.m.

Porridge and milk, egg and bacon or ham, fish, ox tongue, toast, bread and butter, tea or coffee, marmalade, and jam.

Dinner, 1.30 p.m.

Soup (to which peas, beans, lentils, vermicelli or barley are added) or entrée, fish, meat or poultry, potatoes and vegetables, salad, suet puddings, boiled fruit pudding, stewed fruit and cream or custard, cheese and biscuits, bread and butter, fruit and coffee. Milk, 8 to 16 ounces.

Tea, 4 p.m.

Tea and piece of bread and butter or a piece of cake.

Supper, 7 p.m.

Fish, meat, vegetables, milk puddings, stewed fruit, bread and butter salad. Milk, 8 to 16 ounces.

Even this quantity of food with one course of meat three times a day may be found excessive to some patients, when a smaller quantity is given and fish or eggs substituted for supper. We never gave margarine to our patients all through the late war when they had butter in restricted quantities, but now it is given *ad lib.*

The European and Indian vegetarians are treated with excellent results by the following diet:

Porridge, eggs, fish (those who can take it), cheese, potatoes, fresh vegetables, peas, lentils, beans, salads, tomatoes, suet and milk puddings, custard, stewed fruit and cream, bread and butter, fresh fruit, wholemeal and other kinds of biscuits, jam, marmalade, tea or coffee.

Or the more strict vegetarians do well under:

Porridge, cheese, fresh vegetables, potatoes, peas, lentils, beans, salads, tomatoes, puddings of all kinds, eggs, custard, wholemeal bread and nut butter, honey, jam, marmalade,

fresh and stewed fruit, nuts of all kinds, milk or cocoa. So that meat is really not necessary in the treatment of consumption, as I have seen Europeans, Indians, and Arabs get cured of tuberculosis on vegetarian and fruit diet. I myself have treated strict vegetarians—Europeans and Indians—with excellent results. One English lady patient always got ill with indigestion when put on meat diet, and as soon as all red meat was stopped and fresh vegetables were substituted she not only lost all symptoms of dyspepsia, but got a healthier colour on her cheeks. Believe me, man is more than meat, and it is not so much the meat or the vegetarian or fruit dietary as the person behind the food that gives its value and good result.

The secret of successful diet depends more upon attention to economy in diet than by giving way to extravagance. But in one set of cases an exception must be made to the general rule that there should be no forced feeding. Cases do happen, more often in women than in men, who have more or less normal powers of digestion, as seen by a clean tongue, etc., but who are very small eaters and have habitually persuaded themselves that they cannot eat much solid food, and so have got into a weak, neurotic condition. Some of these cases suffer also from nausea and sickness even after taking milk. But through the gentle but firm pressure on the part of the physician and the nurse they take to sanatorium diet, their sickness disappears, they put on weight, and are all the better both physically and mentally. Only in such cases of perverted appetites is a little compulsion justifiable and can be used with advantage.

I have not much faith in beef teas, concentrated essences, in cases of chronic dyspepsia or anorexia. Meat wines are only a subtle way of introducing drink to patients, and some of them, especially women patients, have been ruined physically and morally to my knowledge in this way. We do not always advocate malt or cod-liver oil to aid digestion, but depend more upon milk, butter, and cream to fatten patients naturally if they are below normal weight.

Patients taking ordinary diet do not require three pints of

milk, as advocated by some sanatoria. Large quantities of milk poured into the stomach are apt to interfere with gastric digestion. When patients first come into the sanatorium they are allowed two glasses (each glass holds 8 ounces) a day, which is increased to four; and a glass of milk is substituted in the place of tea if the patient is emaciated. As patients improve, the quantity is gradually reduced to two or one a day. We do not sterilize the milk, as we used to do in the old sanatorium days, as we find our patients thrive better on fresh milk. I am convinced that milk to be nourishing and digestive should not be boiled but given in its raw, fresh state.

Fresh milk has distinct bactericidal properties. It may be, as Matthews[17] says, cooking destroys some vitamines in the milk. Some patients with weak digestion do not digest milk very well. It produces in them acid fermentation, dilatation of the stomach, and other dyspeptic troubles. In these cases it is better given on an empty stomach between meals. The digestive value of milk differs in different persons, and in the way it is taken. From our own experiments we found that fresh milk taken on an empty stomach, or about two and a half hours after a meal, is better digested than when taken with other foods (we know that this is quite contrary to what Atwater[18] found), and this is proved true in our everyday experience. Milk, when soured or fermented or in the form of junket, is more easily tolerated than when it is given pure. The curds of milk is a common food from time immemorial in India and other Eastern countries. Sir James Barr[19] says, that on account of the enormous amount of lime contained in milk, he has condemned the too free use of it except for babes and sucklings.

Sound digestion includes sound teeth and proper mastication. It is surprising what a large number of patients who enter sanatoria have decayed teeth. Very often the patient's temperature and dyspepsia are aggravated by the septic condition of the mouth, if not entirely due to it. The condition of the teeth should be looked into, if possible, before a patient seeks sanatorium treatment.

The nutritive value of foodstuffs depends also upon the physical and mental condition of the patient. The individual who takes his food with pleasure will assimilate it easily, even to the extent of nullifying any noxious qualities of the foodstuffs themselves; whereas he who has repulsion for his food will digest it under the most unfavourable conditions, and distil toxin from the most nourishing foods. This will explain why of two patients eating the same quantity of food, and living under the same environment, one will gain and the other lose. The gain of weight is not in proportion to the quantity of food taken. Nor is it always an index to the patient's improvement in the condition of his lungs. I have seen active mischief continue in fat patients, and arrest of disease take place in those with slender frames. It is surprising how little women patients eat as compared with men and still gain weight.

As a rule we find that the weight curve of the patients is the lowest in the spring and late winter months and highest in summer and early winter months. This experience is somewhat similar to what Strandgaard[20] found in Danish Sanatoria, and to the results in Mundsley Sanatorium, England. Our patients lose most in March and April, from which time the weight curve rises till October, with a slight fall in September. From November the curve goes down slowly, and reaches its lowest in March and April, when it rises again.

The mental and emotional condition of a patient exerts a marked influence upon his digestion. A well-spread table decorated with flowers, etc., attractively served food, cheerful companionship, all have a psychic influence which helps to give appetite and to cause easy digestion. On the other hand, food eaten without relish, a badly served meal, depressing environment, trouble and worry, would take away the appetite and check the flow of alimentary juices which would lower the nutritive value of most nourishing foods.

The maxim 'laugh and grow fat' is scientifically true. A patient with a placid temperament gets more nourishment out of a smaller quantity of food than one with a restless

and irritable frame of mind. Behind food lie the powers of digestion and assimilation, and behind these again the condition of the mind. Worry and anxiety, mental strain and stress, interfere with the physiological functions of the stomach and healthy metabolism. The common saying that a person cannot eat when he is in love has a profound truth behind it. A patient filled with a calm satisfaction and peace of mind does not want much to eat.

It is perhaps because women are more spiritually minded that they eat less in proportion to men. The more a people are materially inclined the more their physical wants may require satisfaction. That man does not live by bread alone is borne out by scientific facts.

Nature laughs at our scientific calculations, our food values in grammes and calories, and brings from her hidden stores materials wherewith to feed her children. Therefore the sanatorium physician, in arranging the diet of the patients under his care, should take into consideration their mental condition and temperament, their habits of life and idiosyncrasies. Only by discretion and individual attention, by neither underfeeding nor overfeeding them, by coaxing the thin to eat more and persuading the obese to eat less, and above all by placing them in a happy and cheerful frame of mind, can he successfully wage war against tuberculosis.

REFERENCES.

[1] The Physiology of Digestion and Nutrition, by Von Dr. Otto Cohnheim, 1908.

[2] 'The Discussion on Animal Nutrition at the British Association, Dundee,' *Science Progress*, January, 1913.

[3] *The Irish Homestead*, September 27, 1919.

[4] Mathilde Hompes, *The Vegetarian*, October, 1917.

[5] Hoobler. *Amer. Jour. Dis. Chil.*, August, 1917.

[6], [7] Knaggs, Indigestion: Its Cause and Cure.

[8] *Brit. Med. Journal*, February 12, 1910.

[9], [10], [11] *Medical Press and Circular*, September 30, 1908.

[12] Shakespeare, *Twelfth Night*, i. 3.

[13] Shakespeare, *Henry IV.*, Part II., iv. 1.

[14] Palier, *New York Medical Record*, January 5, 1907.

[15] Consumption Doomed, by Dr. Paul Carton, pp. 50, 53.
[16] *Ibid.*, p. 51.
[17] Matthews, Physiological Chemistry, p. 313.
[18] Atwater, Pulmonary Tuberculosis, by Fishberg, p. 520.
[19] Sir James Barr, *Brit. Med. Journal*, July 31, 1920.
[20] 'Strandgaard's and Mundsley Results,' by Henderson Smith, *Brit. Med. Journal*, April 21, 1917.

CHAPTER XVII

THE TREATMENT BY DRUGS AND CONTINUOUS INHALATION

Treatment by Drugs.—Since the open-air movement came into existence drugs have taken a secondary place in the treatment of phthisis. They are not of much use in the arrest of the disease, as no specific remedy has been found to kill tubercle bacilli and their toxins. And any remedies like creasote, guaiacol, etc., given by the mouth, in sufficiently large doses to be effectual, are apt to cause digestive disturbance, and are therefore better given in the form of inhalation. J. Moczulsky[1] found that tincture of strophanthus was more potent in heart disease when given in the form of inhalation then when given either by the mouth or intravenous injection. Diet and hygienic treatment have so modified and relieved symptoms such as fever, night sweats, insomnia, indigestion, etc., that drugs are not often wanted in these cases. Any attempt to bring down the temperature in consumption by antipyretics is futile, as the effect is only temporary and may do more harm than good; besides, as we have seen, fever in the early stages is more physiological than pathological, and forms part of the healing process. Sanatorium feeding demands that patients should have their bowels attended to. We find it a good thing to give at regular intervals a calomel pill followed by a saline in the morning. Patients are weekly painted with liniment of iodine, which is very beneficial in enlarged glands, pleurisy, patches of congestion, exudation, etc. To correct indigestion and as a stomachic tonic the following formula is found useful:

Acid. nit. hydrochlor. dil.	ʒii.
Acid. phos. dil.	ʒi.
Tinct. nuc. vom.	ʒi.
Tinct. card. co.	ʒiii.
Syrup. aurantii	ʒvi.
Inf. gentian co.	ad ℥vi.

A tablespoonful three times a day in water between meals.

to which dilute hydrobromic acid can be added with benefit in cases of neurasthenia and allied nervous conditions. In cases of poor digestion and malassimilation Carnrick's secrotogen and kinazyme are sometimes found efficacious. The administration of syrup of hypophosphites or glycerophosphates supplies any deficiency of lime, iron, or manganese in the system. Calcium can also be given with a view to calcification and fibrosis of the lungs. Cod-liver oil which is rich in vitamine fat soluble A may be necessary in some cases of emaciation, though cream and butter are more natural foods and are more easily digested. The night or irritable cough can be relieved by small doses of codeine or heroin. A commencing cold can often be cut short by an alkaline mixture and the use of our mask. One of the secrets of treating pulmonary tuberculosis is to give the gastric organs as much rest as possible from constant drugging and frequent feeding, so that they may effectually carry out their work of digestion and assimilation.

Continuous Inhalation.—Of late years there has been a steady attempt to introduce continuous inhalation in the treatment of pulmonary tuberculosis. At the very outset it should be borne in mind that no single remedy can lay claim to cure all cases of phthisis, which presents many types and many features. Nature has brought about an arrest of the disease in thousands of instances without the help or knowledge of man. In our campaign against consumption we have chiefly followed the ABC treatment—aero-therapeutics or sanatorium treatment, various breathing exercises, and continuous inhalation. Fresh air and food improve the general condition and nutrition. Though they are sufficient to bring about an improvement in early cases

they may not succeed in all. The sanatorium physician has found out that a consumptive must slowly work out his salvation by work and exercise. Hence the introduction of graduated labour as part of the daily programme in a well-conducted sanatorium. But we had to go a step farther, as fresh air and food, rest and exercise, have not always given the best results. Those who had gone into rapture over graduated labour had to admit that it cannot be used in every case, and that it has sometimes failed to arrest the disease. So further attempts have been made to supply this deficiency by medicinal and other treatment, such as drugs, injections, artificial pneumothorax, and continuous inhalation. Injections, as we have seen, have not been a success; artificial pneumothorax can only be used in a very limited number of cases, and is not necessary in incipient cases. Inhalation is one of the best forms of using many volatile and aromatic drugs in the treatment of consumption.

Inhalation Treatment from Ancient Times.—The inhalation treatment has had a long and chequered career. It dates back from ancient history. The idea that volatile substances inhaled into the lung have a beneficial effect on consumption is as old as the ancient Greeks. Physicians in ancient Rome sent consumptive patients to the pine forests of Libya.[2] Even before the time of Hippocrates it can be shown that the germ theory and inhalation treatment were dimly anticipated by the Indians. Susruta, the father of Hindu surgery, advised that incense made of aromatics should be kept burning in a room while the operation was being performed, evidently with a view to purifying the air of noxious substances, in the same way as Lister and his followers attempted to disinfect the air in contact with the wound by carbolic sprays. We read in the ancient works of Charaka, the Hindu physician of classic fame, that different spices, gum resins, and fragrant wood, were ground into powder and made into a paste and smeared over thin tubes or sticks and lighted, and the smoke was inhaled in diseases of throat and chest. Even to the present day the Hindus burn these fragrant sticks in their sick rooms and

in their temples. Galen praised the efficacy of sulphur, and advised his patients to go and live near Vesuvius so that they could breathe the air charged with the fumes of sulphur. As early as 1664 inhalation was employed by Bennett in the treatment of pulmonary tuberculosis. Laennec (1810), the inventor of the stethoscope, in his great work, *Auscultation Médiate et des Maladies des Poumons et du Cœur*, makes mention of the inhalation of vapours from aromatic plants, balsams, myrrh, sulphur, etc., in the treatment of chest affections. Schneider and Valz[3] constructed the first nebulizer in 1829, and in 1847 Auphan[4] applied pulverization and nebulization in the treatment of chronic disease of the respiratory tract. About the same year Salles-Girons[5] established an inhalatorium at Pierrefonds, and for the first time the question was raised and was demonstrated of the possibility of reaching the lungs by these methods. In 1877 Sir William Roberts[6] claimed good results in phthisical cases from the antiseptic inhalation by means of 'respirator-inhaler' which covered the mouth only. Dr. Coghill[7] also employed a similar apparatus in which he used a solution of tincture iodine, carbolic acid, creasote, thymol, and rectified spirit. About 1878 Robert Lee[8] began making experiments on antiseptic vapour by using a jet of steam that came off from a mixture of phenol and water. In 1882 Dr. Burney Yeo[9] advocated a simple oro-nasal inhaler made of perforated zinc, and advised a mixture of creasote, carbolic acid, eucalyptus or turpentine, with equal parts of spirits of chloroform. Hassall,[10] in his treatise published in 1885, threw doubt on the efficacy of oro-nasal inhalers, and stated that the only effective method was to place the patient in a closed room filled with volatile antiseptics which the patient could draw into his lungs during the ordinary process of breathing. But Dr. William Fox,[11] supporting Dr. Yeo, pointed out that inhalations of creasote, thymol, iodoform, iodine or terebene, tend to diminish cough and expectoration, and brought marked improvement even in very advanced stages of consumption. In 1895 Lardner Green and William Murrell[12] in England,

and Dr. Cervello[13] in Palermo, Italy, recommended formalin inhalations in catarrhal and tuberculous infection of the lungs, and reported their beneficial effect in several cases at the Tuberculosis Congress held in London in 1901. In 1905 Dr. David Lees[14] began using continuous inhalation, and has since published results of many successful cases treated by this method. In 1908 Dr. Beverley Robinson,[15] of New York, described cases he treated with inhalation of creasote, alcohol, and chloroform; also Dr. Ruata of Perugia, Italy, wrote enthusiastically about inhalation in the treatment of consumption. The Maggatorium establishments for consumption first opened in 1911 in Bradford, for the inhalation of ammonia, were based on the same idea as that of the ancient Indian physicians who advocated that consumptive patients should sleep with the goats and inhale the ammonia given off from their urinary excretions. It is also noteworthy that after so many centuries the treatment by garlic should be revived in the form of allyl sulphide by Dr. Minchin and others. In 1915 Dr. Bertram Waters[16] employed, in the treatment of pulmonary disease, the vapour of ozonide of pinene, which was known as early as 1865.

Dr. A. Gregor[17] and Dr. Shufflebotham,[18] in their report to the Medical Research Committee, point out that in gasworks the inhalation of sulphuretted hydrogen and chlorine seem to immunize the workers against influenza. Dr. Gregor, working in conjunction with Dr. Benjamin Moore,[19] found that both sulphuretted hydrogen and nitrogen peroxide had a marked effect in inhibiting the post-nasal microbial growth. Tweddell[20] also found that SO_2 inhalations were beneficial in tuberculosis of the lungs and larynx.

If space permitted we could cite the names of many more workers who have testified to the efficacy of the inhalation treatment. After fighting the old prejudices against inhalation treatment for many years, it is pleasant to the writer to see this method steadily gaining its way to the front in the treatment of consumption. While a student of Burney Yeo he was so impressed with his lectures on inhalation in phthisis, at King's College Hospital, that he took up the

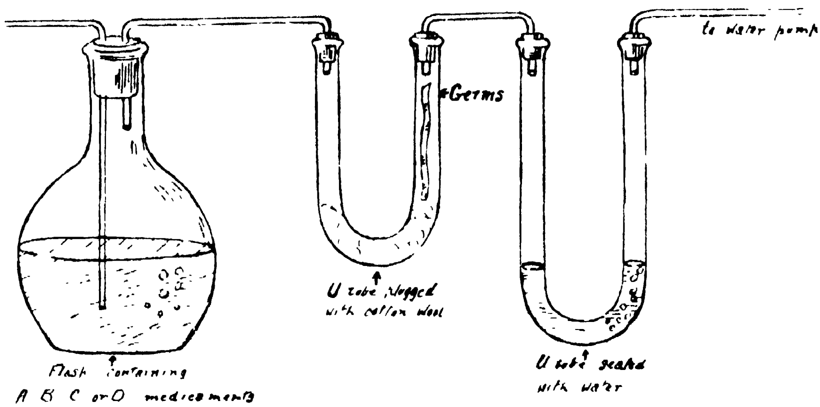

FIG. 24.—CULTURAL EXPERIMENTS ON DR. MUTHU'S INHALANTS.

FIG. 25.—DR. MUTHU'S MASK.

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inhalation treatment in 1895, and more seriously and systematically since 1895 in conjunction with sanatorium treatment, and ever since he has been more and more perfecting the inhalation methods, and using them with greater success and enthusiasm.

Cultural Experiments on Antiseptics.—In 1899 the writer, in the course of some experiments on the antiseptic value of formalin, made the following observations, which were reported at the Tuberculosis Congress, London, 1901:

1. Linen strips dipped in broth cultures of staphylococcus pyogenes aureus, and exposed in a sealed room with a capacity of 2,000 cubic feet to the vapour generated from twenty paraform tablets, showed no growth after six hours.
2. Half to 1 per cent. formalin solution killed a pure culture of staphylococcus pyogenes aureus, bacillus anthracis, bacterium coli communis, bacillus typhosus, within thirty minutes to an hour; and ever since we found formaldehyde to be most efficient and reliable in the disinfection of rooms in our sanatoria.

In 1915 some experiments were conducted at the laboratory of the Sanitas Company to ascertain the germicidal properties of the various inhalants used in our mask. Air was drawn (see Fig. 24) by means of a water pump through a flask containing A, B, C, and D inhalants, then through a **U**-tube containing strips of filter paper, moistened with a broth culture of bacilli typhosus, which exhibit about the same resistance as tubercle bacilli. The result was:

Formula A ...	B. typhosus	was	killed in	45	minutes.
„ B ...	„	„	„	15	„
„ C ...	„	„	„	30	„
„ D ...	„	„	„	20	„

It is true that experimental results obtained outside the body cannot be the same as those obtained within the body. Clinical experience has shown that antiseptics have no specific action on tubercle bacilli within the body cells and

fluids, so that the beneficial action of inhalation treatment must be explained in other ways. Before proceeding with any such explanation, a word or two must be said about the nature of the drugs employed in our inhaler, which come under three groups—The Formalin, the Iodine, and the Pine group.

Formalin is a strong germicide, and is equal in efficiency to corrosive sublimate. It is highly volatile, and possesses a great penetrative power into tissue cells, and destroys the microbes causing fermentative changes. Iodine has been used in medicine from remote times, and its usefulness has steadily increased, especially during and since the great war. It possesses remarkable stimulating power on the secretion of the endocrine glands. It is secreted by the thyroid gland, and is therefore a normal constituent of the blood. It is found deficient in phthisis, and is given in large doses by the mouth in the hope to supply this deficiency in the blood. Bowdreau[21] says that it has a curative action in tuberculosis. Administered in the form of vapour it is more likely to be absorbed than when given through the mouth. The healthful and invigorating properties of the Pine group (which includes pine, eucalyptus, turpentine, terebene, creasote, balsams, etc.), due to their volatile exudations, have been recognized in diseases of the lungs and throat. The physicians of ancient Rome believed that terebinthinate exhalations from the standing pines exerted a most beneficial influence in pulmonary affections.[22] In America, parties are often formed to camp out in the pine forests for a time, and in the pine districts of Scandinavia, the first thing the inhabitants and lumber workers turn to in their illness is the friendly pine exudations.[23] Many of the principal Sanatoria in the world are situated amidst the pine groves, the essential oils of which undergo oxidation in the presence of atmospheric moisture forming peroxide of hydrogen and oxypinene (Kingzett), or ozonide of pinene (Blomen and Waters). In using by inhalation the aromatic vapours of pine, spruce, and balsam trees, we are using Nature's disinfectors, and closely following her methods of healing.

How Inhalation is used in our Sanatorium.—We use two methods in the sanatorium: The lamp method—where formaldehyde is vaporized in a methylated spirit-lamp, containing a hot-water boiler, the inhalation being taken in patients' own chalets or rooms with closed doors and windows half an hour at a time. Thus the chalets form a sort of inhalatorium improvised for the time being, which carries out Hassall's idea of impregnating the air of a closed chamber with volatile antiseptics, so that the patient using the room could not avoid drawing the vapour into his lungs during the ordinary process of breathing. The continuous method—for which we have devised an inhaler after the pattern of Dr. Yeo and Dr. Ruata, which combines all the advantages without their disadvantages. It is not enough to make use of antiseptic drugs for inhalation purposes, but they must be more or less volatile, and be easily taken into the lungs in the form of vapour with the inspired air. The efficiency of the treatment lies in proportion to the degree of diffusibility of the antiseptic mixture used. We use three groups of solutions—formaldehyde, iodine, and pine group. Of all the antiseptic solutions formaldehyde stands first, as it is not only a strong germicide, but is highly volatile, and possesses great penetrating power into tissue cells. It is first introduced to the patient in the A mixture, which is a mild combination, containing only 2½ per cent. in strength, and made pleasant with the addition of menthol, pine, and chloroform. B is a stronger inhalant, containing 5 per cent. of formaldehyde with menthol and pine, and the whole dissolved in chloroform and alcohol. In this way I have given formaldehyde in hundreds of cases, and even to young people, without any difficulty. It possesses the property of hardening the mucous membrane of the nose and air passages; hence the patients do not feel any inconvenience after a few days. After B, the patients go on to C. B and C and D are our standard mixtures, containing guaiacol, pumiline pine, and terebene. Guaiacol is much more easily absorbed and is less irritating than creasote. Where, in a very few cases, formaldehyde is not tolerated, or where

pulmonary tuberculosis is complicated with affections of the nose and throat, C and D solutions are tried from the beginning. The advantage of having more than one solution is this: the monotony of using the same mixture over and over again has a wearying effect upon the mind, whereas a constant change of inhalants keeps up fresh interest in the treatment till success is achieved. Besides, all the solutions in succession give the patient the advantage of trying many antiseptic drugs in the course of the treatment. Both the inhaler and the mixtures are manufactured by Messrs. Oppenheimer, Son and Co., Ltd., London.

The mode of procedure is as follows: When a patient first comes to the sanatorium he is sent to bed and kept there if he shows any signs of a rise of temperature. He has the inhaler for two hours the first day, four hours the second, six hours the third, and eight hours the fourth and the following days. In this way he is gradually prepared to use the inhaler a great part of the day as well as the night. Patients keep on the inhaler while they are walking, resting, reading, or playing games, etc. In fact, they are encouraged to keep on the mask at every opportunity from the time they wake up in the morning till late at night, and even during the night. And as they improve and show signs of arrest of the disease the hours are gradually reduced to six, four, and two hours a day. The following are the formulæ of the various solutions:

A.	Formaldehyde	2½ per cent.
	Chloroform	ʒj.
	Menthol	gr. x.
	Ol. pini pumilin.	♏x:
	Spt. vin. rect.	ad ℥j.
B.	Formaldehyde	5 per cent.
	Guaiacol	ʒj.
	Chloroform	ʒij.
	Menthol	gr. xv.
	Ol. pini pumilin.	♏xv.
	Spt. vin. rect.	ad ℥j.

C.	Guaiacol	ʒij.
	Terebene	ʒj.
	Menthol	gr. xv.
	Ol. pini pumilin.	♏xv.
	Chloroform	ʒij.
	Spt. vin. rect.	ad ℥j.
D.	Guaiacol	ʒij.
	Tinct. iodine	ʒj.
	Terebene	ʒj.
	Ol. pini pumilin.	♏xv.
	Chloroform	ʒij.
	Spt. vin. rect.	ad ℥j.

N.B.—About 10 drops to be sprinkled on the inhaler every half to one hour.

One or two words of caution are here necessary for carrying out the treatment effectually. See to the purity and fresh quality of the drugs used. As formalin contains more than 50 per cent. of water, formaldehyde is conveyed into the inhalants in the form of gas to make them more volatile. Hence the solutions A and B, if not all, are better obtained from the manufacturers who have taken special pains to ensure the purity and excellence of the inhalants. Keep the mixtures in brown stoppered drop bottles, as they are very volatile. Change the lint in the mask as often as necessary; it is better to have two inhalers for day and night use; the inhalers must be worn at least eight hours a day or more for the first few weeks. It is absolutely necessary for the patient to live, as it were, with his mask, and make it his friend and constant companion. The secret of success of the inhalation treatment very largely depends upon carrying it out continuously and perseveringly.

Mode of Action.—Here again one is compelled to remind the reader that the bacterial action has been exaggerated at the expense of the physiological and chemical action of the drugs used in inhalation treatment. Very likely antiseptics make their way into the pulmonary alveoli if the inhaler is used for a sufficient length of time. Also it is quite possible that the action of pathogenic organisms in the nasal, throat, and mucous passages is inhibited by the volatile vapours of

drugs, as Dr. Gregor and others have shown. But we know that antiseptic treatment has not been a success in pulmonary tuberculosis. The administration of iodine in many forms, the injection of formalin with a view to destroying specific organisms within the tissues, have not brought satisfactory results. We believe that the beneficial results—sometimes very startling results—of continuous inhalation are more due to the physiological, chemical, and other action of the drugs than to their germicidal properties. The great majority of inhalants act as a stimulant on the morbid mucous membrane, causing a healthy flow of blood, hyperæmia, increased secretion, liquefaction, and destruction of pathological tissues, which are either destroyed or absorbed by phagocytic action. These stimulating, expectorant, and absorbent properties bring about a healthy action of the affected mucous membrane which is clinically seen in the allaying of cough and diminishing of expectoration. Iodine has a further stimulating action on the thyroid gland, and through it on other endocrine organs, which favours increased metabolism and general nutrition. Since phthisis is associated with diminished secretion of the thyroid, the therapeutic value of iodine can be explained when administered in the form of inhalation. Mechanically, the wearing of the mask in silence for many hours creates a restful atmosphere. Patients are obliged to keep quiet, and this restful effect is best seen in laryngeal tuberculosis. Besides, the rest from talking keeps the patient from coughing, which gives Nature breathing time to go on with her beneficial work in the diseased areas.

More important still, the wearing of the inhaler causes an impediment to inspiration, and provokes a certain amount of increased negative pressure in the thorax which causes an increased determination of blood to the lungs, as in the congestive method of Bier. This hyperæmia, brought on by inspiration against resistance, resembles the action of the rarefied air of high altitudes, and results in the increase in the number of red corpuscles and hæmoglobin percentage in the blood. Experiments are in progress to ascertain how far this increased red corpuscular count is due to the mask or to the altitude and other effects of sanatorium treatment.

Also this increased respiratory resistance induces the costal type of respiration, widening the chest, and strengthening and developing the respiratory muscles. So that we are certain that the curative action of the mask, especially in chronic pulmonary disease, is in some measure due to hyperæmia and to the enlarged capacity of the upper part of the lungs—parts most prone to tuberculosis—caused by this mechanical resistance.

Lastly, the psychic effects of the mask are real and great. The inhaler keeps the patient's time occupied and his mind from dwelling too much on his disease. He feels that something tangible is being done for his case, and that he is doing something himself to get well, and this constant suggestion is further helped by the experience of benefit in himself and in others which still more inspires confidence and hopefulness in the treatment, and gives determination to use the mask continuously.

So that we believe that the physiological, chemical, mechanical, and psychic effects of the inhaler far outweigh any benefit derived from the germicidal action of the drugs employed. We know from our own experience in hundreds of cases, that inhalations diminish cough and expectoration, reduce temperature, and help in bringing about the arrest of the disease. Many years of close observation have convinced us that continuous inhalation has rendered us great assistance in fighting consumption, so much so that it has become a daily part of the sanatorium treatment.

In conclusion, continuous inhalation is simple and easy in its application, can be used at all times, incurs no risk (it is best not to use the mask during an attack of hæmoptysis), and can be carried out at home with advantage if a sanatorium is not available. It affords the patient protection against strong winds and dust when he takes his walking exercise. It can be used in bronchitis, asthma and bronchiectasis, a case of which was successfully treated in 1908, and reported in the *British Medical Journal* (September 23, 1911). The use of the inhalant is almost a specific in infectious colds and catarrh of the nose, head, and throat, and prevents them

from spreading downwards or starting fresh mischief in the lungs. So it has many uses and an extended scope of usefulness in phthisis and many other affections waiting for the physician to give it a fair trial, and see that his patients use it continuously and perseveringly.

REFERENCES.

[1] Moczulsky, *Wien. Med. Woch.*, January 8, 1914.

[2] Atmospheric Air in Relation to Tuberculosis, by Hinsdale, p. 3.

[3] Bertram H. Waters in *Medical Record*, New York, February 13, 1915.

[4] Auphan, Traitement hydro-minérale de la Chlorose et des ses Complications, Paris, 1868.

[5] Salles-Girons, 'Sur la Respiration des Eaux minérale pulvérises,' *Gaz. heb. de Méd.*, Paris, 1861.

[6, 7] 'Continuous Antiseptic Inhalations,' by David B. Lees, *Brit. Med. Journal*, December 11, 1909.

[8] 'On the Use of Antiseptic Vapours,' by Robert Lee, *Medical Press and Circular*, October 7, 1908.

[9] Same reference as 6 and 7.

[10] The Inhalation Treatment of Diseases of the Organs of Respiration including Consumption, by Hassall, 1885.

[11] Same reference as 6 and 7.

[12] 'Inhalation of Formalin in the Treatment of Phthisis,' Lardner Green, *Brit. Med. Journal*, January, 20, 1900.

[13] Transactions in British Congress on Tuberculosis, 1901, vol. iii., p. 416.

[14] 'A Third Series of Twenty Cases of Pulmonary Tuberculosis treated by Continuous Inhalation,' by David B. Lees, *Brit. Med. Journal*, April 6, 1912.

[15] 'Creosote in Pulmonary Tuberculosis,' by Beverley Robinson, *Amer. Jour. of Clinical Med.*, July, 1909, and *New York Medical Record*, January 24, 1920.

[16] 'An Experimental Study of a New Remedial Agent and its Effects in Pulmonary Tuberculosis,' by Bertram H. Waters, *Medical Record*, New York, February 13, 1915.

[17] *Brit. Med. Journal*, 1919, vol. i., p. 242.

[18] *Ibid.*, 1919, vol. i., p. 478.

[19] *Ibid.*, 1919, vol. ii., p. 523.

[20] *Tubercle*, 1919, vol. i., p. 24.

[21] *Jour. de Méd. de Bordeaux*, June, 1917.

[22] Same reference as 2.

[23] 'Some Studies in the Oxy-pinenes,' by Blomén, *Amer. Jour. of Pharmacy*, May, 1915.

CHAPTER XVIII

PSYCHO-THERAPY IN PULMONARY TUBERCULOSIS

'Just as you ought not to attempt to cure the eyes without the head, or the head without the eyes, so neither ought you to attempt to cure the body without the soul.'—PLATO.

'In medicine the spiritual is never wholly divested of the material, and the material is never wholly withdrawn from the influence of the spirit.'—SIR CLIFFORD ALLBUTT.

WE have so far considered the treatment of pulmonary tuberculosis from the physical standpoint; but man is more than body—he has also mind and soul, which can exert their influence over the body in the cure of disease. Only an insignificant part of man is visible and tangible, while the most important part remains invisible and is in touch with the unseen forces beyond. As Dr. Hadfield[1] says: 'The limits of possibility in our daily lives are defined less by the body than by the mind, and the resources of power are psychic rather than physical in character.' This is why physical methods alone are not sufficient to bring about healing,[2] and the physician is often baffled by the limitation of his healing powers. It is too late in the day to ignore the operations of the psychic and the spiritual world. When in 1910 the *British Medical Journal* opened its columns to the discussion of 'Medicine and Miracles,' and invited eminent medical men to relate their experience, modern medicine entered a new era, and psycho-therapy received its official recognition. The employment of psycho-therapy during and since the Great War in functional disorders such as neurasthenia, shell shock, etc., brought the study of psychology still more prominently before the profession.

Psycho-Therapy from Ancient Times.—The practice of healing by suggestion and faith dates back from the remote

ages. The temples of the East, of Babylon and Egypt, of Greece and Rome, were centres of healing, where the followers of Æsculapius and Serapis, of Isis and Mithra, brought their sick humanity to be cured of their gods. After the Apostles the gift of healing remained in the Christian Church for three centuries.[3] Origen,[4] writing in the third century, declares that the Christians of his day performed many cures. When Christianity supplanted the ancient religions, many of the pagan temples were converted into Christian churches, and cures of the same kind continued to be worked in them in the name of the saint who took the place of the ancient god.[5] Among the thronging pilgrims to Mecca, to the sacred rivers and temples of India, to the shrine of Buddha, to the grotto of Lourdes and to a hundred other places in the Catholic Church, some return with restored health as a reward of their faith. Touching for the King's Evil did no doubt effect many cures—the royal touch, accompanied by kind words, having brought a stimulating effect and a healthy reaction in the body.[6] Many religious founders and leaders, from Mohammed to George Fox the Quaker and John Wesley, have exercised the power of curing the sick.[7] In the medical world long ago Galen[8] said that he worked the most cures in those who most had faith. Paracelsus,[9] centuries after, wrote: 'Faith produces miracles, and whether the object of your faith be real or false, you will nevertheless obtain the same effect.' Burton, in his *Anatomy of Melancholy*, says that 'an Empirick oftimes, and a silly Chirurgeon, doth more strange cures than a rational Physician.' In our own times, Osler[10] reiterated this truth when he writes: 'It is from faith which buoys up the spirit, sets the blood flowing more freely, and the nerves playing their part without disturbance, that a large part of all cures arises.' So the history of faith healing from the beginning of recorded times has been mixed up with relics and amulets, holy grottos and pilgrimages, magnetism and mesmerism, theosophy and occultism, Christian science and Emmanuelism, hypnotism and psycho-analysis—all of which have cast a mystic spell upon the subconscious mind which more or

less brought energizing power to the body and renewed health.

Even now, if our eyes are open and our minds are free from prejudice, we can see 'miracles' being performed every day—tumours of long standing disappear, cancer cured mysteriously, and consumption healed of its own accord. Sir Henry Butlin[11] states that 'there are individuals who spontaneously get rid of tumours that are authenticated cancers. Many such cases are on record.' And he quotes a case from his own practice of a patient suffering from epithelioma of the lower lip which he operated three times, when the lip and glands were removed, most of the soft structures cut away, first the contents of the anterior and afterwards of the posterior triangle of the neck were cleared out, and the wound was closed without any hope of saving the life of the patient. The disease progressed, and further operation was found impossible; but in three months the patient began to improve, the induration gradually cleared up until not a trace of the disease could be felt, and the patient was in perfect health at the time Sir Henry was writing—*i.e.*, five years after the operation. If we can understand the psychology of power and faith, we shall know the psychology of spontaneous cures, and, for that matter, of any cures. And every physician can speak from personal experience of patients who lay at the point of death with no hope of recovery, but who, nevertheless, to his surprise, got well completely. Indeed, in every bottle of medicine, every box of pills, every tuberculin injection, and every kind word of cheer and hope to the patient, the physician is unwittingly employing the power of suggestion for the cure and arrest of disease, just as the priest finds that colour and music, candles and incense, have a suggestive effect on the worshippers.

It is rather unreasonable to say that things which pass our comprehension are contraventions of the laws of Nature and therefore cannot be true. What we cannot understand or fathom may happen every day. It may seem a miracle to a child when he can speak to his father some hundred

miles away, but to the telephone operator it is everyday experience. Every vital process in the body is in reality a miracle. 'We are ever in the holy place,' ever close to the borderland of mystery, and the physician is often unconsciously engaged in taking his patients to the pool of Bethesda and making them whole.

The recent development of experimental psychology has shown that there are matters that lie outside the sphere of physiology and pathology, outside what can be seen under the microscope and in the laboratory. At the present day it must be acknowledged that there exist powers and functions of the human mind which transcend anything that could be explained upon a materialistic basis.[12] There are bodily ills which cannot be cured by pills and potions and which yield to suggestive treatment. We medical men have not the monopoly of the cure of all disease. Many a case gets well by means outside the influence of official therapeutics. Man being a triune being, the physical, the psychological, and the spiritual parts, as representing the body, the mind, and the spirit, are inextricably bound up with one another in disease and its treatment.

How can Psychic Phenomena be Explained?—It is not the province of this volume to enter into this subject. We can only refer to the question briefly by way of introduction to the treatment of pulmonary tuberculosis. Here we are dealing with an intangible subject, and therefore all explanation must necessarily be vague and suggestive rather than definite and explicit. The modern study of psychology shows that man's real self lies underground like the roots of a tree, as William James nearly twenty years ago spoke of man's 'whole system of underground life,' which controls all the visible phenomena of life and its functions. The real or invisible self is described as being composed of the mind and spirit. The mind of man consists of: (*a*) the subconscious or diffused, or unconscious mind, (*b*) the conscious or circumscribed and reasoning mind, which has the power of resisting suggestion; (*c*) and between the subconscious and the conscious mind is the intermediate region of partial con-

sciousness, as Canon Barnes describes it, where experience exists 'half remembered and half forgot.' The subconscious mind with which we are here chiefly concerned is the seat of instinctive emotions, feelings, and impulses, is at all times alive and receptive to suggestions and thought forces from without, and is *en rapport* with subconscious minds and their radiations from the outside world. It also controls through the nervous system the physiological functions of the body, such as the circulation, digestion, and assimilation; the glandular activities, the process of repair, etc. The lower animals, primitive races, and children in whom the conscious mind is not fully awake or developed, are more receptive to suggestive impressions than adults and civilized beings. The power of suggestion has a far greater influence in the hypnotic state than in the waking state, and hence suggestive therapeutics is made use of in the cure of many functional disorders under hypnosis. The subconscious mind forgets nothing; every thought and feeling, every incident and experience, is recorded as upon the waxen cylinder of the phonograph, and becomes conscious in a sudden stress, as in drowning, accident, etc. Streams of thought and suggestion are constantly being given and taken by our subconscious minds, which exert a physical, mental, and spiritual influence upon ourselves and others.

Deeper than the subconscious mind (or higher, whichever way you look at it) is the sphere of the spirit, which is the reservoir of higher forces—the very bed-rock of man's existence, which is *en rapport* with the Divine energy, the source of all energy and life. The mission of religion is to bring a conscious communion between the human and the Divine Spirit through faith, so that the Divine energy may freely flow into man's being. Hence faith healing is carried out by many religions, including Christianity. In this sphere also reigns personality which looms largely in psychic and faith healing. It is personality that gives confidence to the operator, begets confidence in the patient, and makes suggestion effective. A weak man with a weak personality has no confidence in himself, and cannot create confidence in others,

and hence his suggestion fails to have any result. In the spirit plane words need not be used to create suggestive effects. The very atmosphere gets charged with hopeful or depressing thoughts, which either strengthen the patient and stimulate his vital actions or depress and lower the tone of his nervous system, causing a toxic effect on the glands and their secretions. In this sphere the power of sight and touch also come into operation. The eyes of a strong personality emit magnetic rays, and the touch discharges electricity, as at the finger ends of a masseur, bringing a soothing and stimulating effect on the patient in a manner somewhat similar to the effluve from the static brush. The sphere of operations of the mind and spirit cannot be entirely separated, but blend in their influence and activity. Only, the work of the spirit goes deeper and touches the very centre of life. In both, suggestion, confidence, faith, and hope are the media by which springs of energy are unlocked. It is the free, unrestrained, easy flow of energies bathing every part of a man's being that make for harmonious action, health, and well-being. If, on the other hand, there is mental stress, fatigue, depression, and suppression of energies which cannot find an outlet, but are forced underground as it were, the flow of vital force becomes restricted or diverted into abnormal channels, producing morbid complexes, and disease if the stress is continued for a length of time.

Besides suggestion from without, man, through his personality, can give auto-suggestion to his own self. The stronger the personality the more effective will be the auto-suggestion which may work for good or evil. If it be one of confidence, hope, and cheerfulness, the mind is set at rest, and this restful mind gives power to decisive action, bringing success, health, and happiness. As Professor Sully[13] said, when we believe in a thing our minds are at rest, and we are in a state of readiness to act. But if the auto-suggestion be one of doubt and fear, the healthy energies get repressed, the wrong stimulus opens the door to poisonous secretions and toxins which go to swell the ranks of our dyspeptics, neurasthenics, and hypochondriacs. It is well

known that fear and panic can promote disease, the fear of cancer produce cancer, and auto-suggestions of despair cause even death.

So the chain of psychic process runs something like this: The strong personality begets confidence, confidence suggestion, and suggestion confident expectation which opens up the deep reservoirs of emotions and feelings which strengthen the will, bring confidence and hope, and, operating upon the nervous system, influence all the bodily activities, such as the circulation, digestion, and nutrition. We cannot limit the healing possibilities of suggestion and faith. Their sphere of operation is boundless. When the Master said: 'According to thy faith be it unto thee,' He spoke the language of modern psychology. It is the psychology of faith that heals, and in this sense it is the patient who, in the last resort, heals himself.

Psycho-Therapy and Pulmonary Tuberculosis.—The psychological factor enters very largely into pulmonary tuberculosis—throughout its etiology, in the course of the disease, in the treatment and after-care. We must recognize that with the physical ailment the mind of the patient is also ill. Only as we lay ourselves out to deal with this aching mind by studying the patient's psychological traits, his mental disposition, his human characteristics and tendencies, can we be successful in helping to arrest the disease. While the operation of the conscious mind is somewhat in abeyance in his diseased condition, his subconscious mind is more receptive to the voice of suggestion. This may be a beneficent provision of Nature to help the patient in the restoration of his health, provided the suggestions are healthy and hopeful in character. No disease is so open to be readily influenced by suggestive treatment as consumption. Abounding hope and optimism are a marked trait of the disease. But we do not believe that the physician should take advantage of this spirit of optimism by falsely raising the hopes of the patient in advanced disease, or pretending to cure him by harmless injections. Such a procedure would only end in disaster and disappointment. But when sug-

gestion is judiciously directed in the course of the treatment at the right psychological moment and in as natural a manner as possible in moderately advanced cases, it comes as a distinct aid to the various physical treatment which we have been considering in the foregoing chapters. We shall now briefly describe some of the ways in which suggestive influences have been of help to our patients.

(*a*) **Cheerful Environment.**—Cheerful surroundings of the sanatorium, the healthy looks of the senior patients, the presence of those who are able to carry out the full sanatorium programme, and of those who have recovered and are ready to leave the institution—all these go to create a hopeful impression on the new patient. We do not believe that sick people should attend consumptive patients, or advanced cases be admitted into the sanatorium. These are constant reminders of illness, and a source of depressing and morbid thoughts which would unconsciously tend to retard the patient's recovery. Healthy thoughts and surroundings are essential to create healthy bodies. This is why the constant meeting of happy and healthy faces of the attendants, nurses, and physicians brings confidence and thoughts of health to the sick during their sojourn in the sanatorium. The open-air life, the new daily programme, the regular hours for walks, the open country, the rest before meals, the well-spread table, the pleasant companionship, the fun and laughter of the well patients, subconsciously help to impart new life and buoyancy and cheerfulness to the new-comer. The calm and quiet surroundings, the rest and silence hours, the long hours of sleep, bring a spirit of restfulness to his soul, and create an atmosphere where his jaded energies begin to revive and evoke a healthy response in his subconscious mind.

Rest and Silence Hours.—Rest has physical and psychic effect upon the body. We have found that the physical silence brings remarkable benefit to the patient suffering from laryngeal tuberculosis. Here the complete rest to the voice helps to bring healing to the throat. In sleep, which is 'Nature's soft nurse' and 'balm of hurt minds,' there is

both rest and silence. All the psychic effects of suggestion are enhanced in the atmosphere of restful silence; for in such a quiet surrounding the subconscious mind comes out like the stars in the still night and manifests its stores of energy and healing power. Silence hours are part of the sanatorium treatment. The fact that the materialistic West has insisted upon the silence hours before the principal meal hours in almost every sanatorium shows how instinctively it has grasped the meaning and efficacy of silence. When during the rest hours the consumptive patient lies on his reclining chair or on the bed in front of an open window, with his muscles completely relaxed, his eyes closed, lying still and doing nothing, he finds that this sheer abandonment brings a calm and restful peace to his whole body. The more deeply he learns to relax every nerve and muscle of the body and lie in a passive state, the more quickly he will realize the benefit of peace and power. There is virtue of healing in silence. During the silence hours our patients are advised to give healthy auto-suggestions, and to surround themselves with thoughts of health and expectant faith, and to speak to their inner selves something like this: 'I wish to get well; I want health force to bathe every part of my being. I want to get well as quickly as possible and return home to my work and my people. I am not going to be ill; health is natural. I am going to be well soon,' etc. Such auto-suggestions are a mental exercise which strengthens the will power. The thoughts of health, of home and dear ones, of loving companionships, will bring a power of determination to be cured of the disease. 'As a man thinketh, so is he.' We have known Indians who willed to die and concentrated their thoughts on death, and they died; and we have also known very ill patients who determined to get well, and they got well (when their life force was not too low to be revived). There is nothing novel or strange about speaking to our subconscious minds. We give auto-suggestions when we wish to get up at a certain time; the subconscious mind obeys, and we get up at that time. The truth is that the Western people do not exercise

their minds or their will power in matters of health and disease as strenuously as they do in business affairs, where they have made up their minds to succeed and have succeeded. For just as in the physical world symptoms of disease are a part of healing process, so in the mental plane concentration of thought and determination of will bring with them power and strength. Apart from the effects of auto-suggestion and converse with the inner self, which the patients would do well to cultivate, the benefit of mere complete repose and relaxation is wonderful, if the reader would but try. For complete relaxation and stillness open the door to the inner shrine from which issues all power. The quiescence of mind is itself the most perfect rest. That the life of energy is dependent on the art of resting is one of the fundamental laws of physiology as well as of psychology. The patient needs periods of mental repose, and he can make use of the silence hours to provide him with this mental rest and draw supplies of energy for the healing of his lung. For 'in quietness and confidence shall be your strength,'

> 'And out of that tranquillity shall rise
> The end and healing of our earthly pains,
> Since the mind governed is the mind at rest.'[14]

(*c*) **Occupational Therapy.**—Since the alternation of rest and exercise is necessary for the activity of life, working should go hand in hand with resting. Occupational therapy has a psychological value in the treatment of pulmonary tuberculosis. The tendency of consumptive patients is often to exaggerate and brood over their illness, and the loss of time they sustain in being laid up, and to give rein to morbid thoughts, all of which are apt to depress their minds and lessen their vital resistance. But games and recreation, or some useful occupation, like the various exercises as previously described (Chapter XV.) cheers them up, soothes their nervous system, keeps their mind occupied, and makes them forget their illness. To give an instance of the beneficial effect of work from our experience: A patient, a lady teacher, after a long struggle with tuberculosis, began to mend. But the

long-drawn illness and the daily routine for many months in the sanatorium began to tell upon her nervous system, and she could neither eat nor sleep. She was given some congenial work to do which engaged her interest, and her interest grew as she realized that she was rendering some real service which was appreciated. That work was her salvation; it saved her from a nervous breakdown, and helped her to conquer the disease.

In the way of handicrafts our patients are allowed to weave raffia, do knitting, crocheting, lace making, embroidery, dressmaking, cotton, silk or wool work, make bags, mats, etc., to learn typewriting, etc. For more technical work, such as toy-making, wood-carving, joinery, basket-making, etc., skilled helpers may be necessary to visit the sanatorium and teach the patients. By thus keeping the patients usefully employed in many ways the physician seeks to create a healthy reaction of the mind and spirit over the body, and to produce a healing effect upon the lungs.

(*d*) **Static Electric Treatment.**—Besides its therapeutic effects, static electricity in a humble way has also a psychic effect on the consumptive patient. When he comes under the physician's observation, his health is generally undermined, the appetite is impaired, and the nervous system is in a low, irritable condition. In such cases we have found that the various static modalities, applied intelligently, act like a general tonic, brace up the nervous system, stimulate the functions of the body, increase metabolism and promote general nutrition. It is more with a view to the soothing and suggestive effects that the writer uses this kind of electricity. In those patients who are depressed, cannot sleep, suffer from dyspepsia, and are easily tired and worried, the application of static breeze and static bath, when they are comfortably seated on a lounge chair on an insulated platform, soothes the nervous irritability and brings a feeling of restfulness and calm. While the patient is thus in a state of drowsiness or even of light sleep, the writer gives the suggestion treatment. In these soothing, stimulating, and suggestive effects we have found static electricity a useful help in the treatment of pulmonary tuberculosis.

(*e*) **The Sanatorium Physician as a Psycho-Therapeutist.**—'The basis of the entire profession of medicine,' said Osler, 'is faith in a doctor and his drugs, and his methods.' This faith commands confidence and wins success in the healing or arrest of disease. A sanatorium centres round the personality of its chief physician. Gobersdorf will ever be associated with Brehmer, Falkenstein with Dettweiler, the parent Nordrach with Walther, and the Saranac Lake with Trudeau. An efficient sanatorium does not mean a well-equipped place; for a plain building and the right man will achieve better results than a well-appointed institution and an inefficient head. A ship may be very beautiful to look at; it may be fitted up with modern and improved machinery, and furnished with every imaginable luxury; but it will remain as a useless thing unless it has a worthy commander to guide its destiny. So the success of the sanatorium largely depends upon its chief, the head. It is he who directs the whole machinery, and gives life and stimulus to the whole treatment. His personality is everything, and is made up of his insight into character, patience, perseverance, abounding confidence in himself and in the method he adopts, sympathy which does not outrun a certain amount of discipline, and discipline not rigid and severe as if he were training a band of soldiers. This personal factor is a psychic factor which enables him to meet every new situation and give each patient that individual attention and treatment necessary to the arrest of the disease.

His psycho-therapeutic qualities will be called into play all through the patient's stay in the sanatorium. Every visit and every examination he makes gives him an opportunity to impart optimism and confidence to the patient. These constant suggestions of hope and cheer on the part of the physician, irrespective of the condition of the patient, should form a very important part of the treatment.

Besides his personality and psychic gifts he must be full of enthusiasm. Unless he is enthusiastic he will soon lose heart if he is at all sensitive; for his work is very exacting and often thankless. In addition to having to fight the

many phases of the disease, he has daily to meet many idiosyncracies, temperaments, and prejudices. He will also require wisdom and statesmanship to correct wrong tendencies, to rectify bad habits of a lifetime, to relieve dull ennui, to divert the minds of the patients from dwelling too much upon their disease and to widen their outlook and interest. By constant supervision, by judicial repetition of advice and warning, by regular irregularity, and not too much system and method, but discipline tempered with relaxation, he attacks disease from all points and brings about its arrest by appealing to the physical, moral, and psychic sides of his patients. He may meet with disappointments and failures, or become disheartened by selfishness and ingratitude; but he must keep his ideal ever high—the ideal of doing good to suffering humanity. Strong, brave, and enthusiastic, he must mount his solitary bridge and keep his lonely vigils on the ship, since in his right command and steering lie the welfare and the safety of those who have placed themselves under his care and protection.

REFERENCES.

[1] Hadfield, The Spirit: God and His Relation to Man. Macmillan and Co., London.

[2] Claude O'Flaherty, The Medical Profession and Mental and Spiritual Healing.

[3], [4] The Higher Medicine, by Stenson Hooker, pp. 152, 153.

[5] Miss Mary Hamilton, Incubation in the Cure of Disease in Pagan Temples and Christian Churches, 1906.

[6], [7] Treatment by Hypnotism and Suggestion, by Lloyd Tuckey, p. 30.

[8], [9] Haberman in *The Medical World*, May 7, 1914, p. 725.

[10] *Ibid.*, p. 726.

[11] Sir Henry Butlin, *Brit. Med. Journal*, June 18, 1910.

[12] Science and the Soul, by Reinhardt, p. 127.

[13] *Ibid.*, p. 255.

[14] Same as reference [1], pp. 109, 110.

CHAPTER XIX

SOME RESULTS OF THE TREATMENT AND AFTER-CARE OF PATIENTS

WE have so far followed the various phases of the etiology and the treatment of pulmonary tuberculosis, and have seen that the most rational and satisfactory way of dealing with the disease is by strengthening the weakened constitution rather than by trying to destroy the contagion, and that the open-air treatment by bringing healthy nutrition and increased vitality enables the patient to get rid of the disease in course of time. Now we shall proceed to make a brief study of the results of the sanatorium treatment and the after-care of patients.

The statement that statistics are fallacious finds no better illustration than when an attempt is made to compare and classify the results of the open-air treatment in various consumptive sanatoria. A disease like consumption, with its insidious beginning, its many clinical varieties, its chronic course, and gradual amelioration of one or more symptoms till health is slowly established, presents such a wide basis that it does not easily lend itself to such strict statistical control as measles or smallpox, which present distinct symptoms and run a definite course. Hence any classification either of the disease or its cure is met with many difficulties. For instance, can we classify pulmonary tuberculosis according to its different stages or its symptoms, or according to the number of lobes involved? The terms 'early,' 'advanced,' etc., are not only vague and elastic, but what one physician would consider early symptoms another might think moderately advanced; or the symptoms of the first stage may shade off into those of the second, the second into those of the third. If the extent of the disease is to be

expressed by the number of lobes affected, while in one case two lobes might be slightly affected, in another only one lobe may be diseased but in an advanced cavity stage. When we come to form some idea as to the termination of the disease, we are confronted with fresh difficulties. What is the evidence of cure or arrest of pulmonary tuberculosis? (*a*) Not the absence of tubercle bacilli in the sputum. Many patients who leave the sanatorium strong and well have bacilli in their expectoration; on the other hand, a patient may be very ill, and very badly affected, and still he may have no bacilli in the sputum, or no expectoration. (*b*) Not the

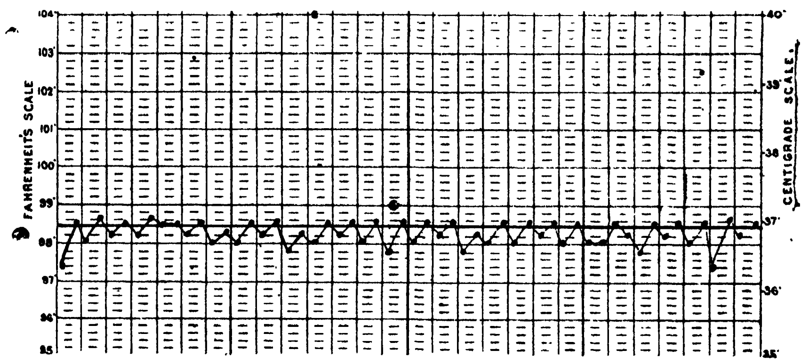

FIG. 26.—SHOWS A NORMAL TEMPERATURE IN A PATIENT WITH EXTENSIVE DISEASE.

absence of temperature; for extensive disease of the lung may be accompanied by a normal or subnormal temperature. (*c*) Not the absence of cough or expectoration; for some of the patients who are discharged from the sanatorium fit for work bring up expectoration for months after. (*d*) Not increased weight; a lean patient is often more capable and efficient than a fat and florid one. Again, when we come to look at the terms 'cure,' 'arrest,' etc., what one physician would report as cured another would say is arrested. Besides, the disease may be cured in one part, and arrested or improved at another part of the same lung. But for a correct appreciation of results of the sanatorium treatment one must know the extent of disease when a patient enters an establishment. Hence some kind of classification becomes neces-

sary to mark what the treatment has done. And to avoid much confusion and error it is wise not to go in for an elaborate analysis, but to make the classification simple, and at the same time clear and definite, so that it may be easily understood and adopted by all the sanatoria. For instance, we would divide all the cases that enter a sanatorium into early, moderately advanced, and advanced. In the early cases we would include all those which are seen to be in the various periods of the first stage, up to the time when the bacilli have appeared in the sputum. They will include all those which present dry physical signs, with a temperature varying from normal to below 100° F., where there may be cough, but no expectoration and no bacilli.

The second division will include all those cases which have begun to expectorate, with or without tubercle bacilli, where one or two lobes are affected, and the temperature is normal or moderate, being below 101° F., and where the gastric functions are unimpaired, and the patients are able to take their daily exercise.

The third will include all cases of advanced cavity stage, or in which disease is extensive, with a hectic temperature going up to 102° F. or more, which present symptoms of mixed infection, great emaciation, rapid pulse, gastric disturbance, and intestinal complication.

The return of health can also be classified under three headings. The first will include cases of complete restoration presenting more or less all negative symptoms—viz., no physical signs, no cough or expectoration, or bacilli, or temperature. The second will include cases arrested or greatly improved, where the physical signs, expectoration and bacilli, have not entirely disappeared, but where the patient feels well and strong enough to do some work. The third will include all those who have made little or no improvement. The practical results can also be classified in three divisions. In the first the patient will be fit for ordinary work, in the second for a little less than ordinary or for light work, and in the third for little or no work. As pulmonary tuberculosis is better studied and known by the

physician, we take it that he will not let his patient reach the advanced condition, but will be able to grapple with the disease in the early stages.

Results of Sanatorium Treatment.—It is not possible to make an accurate tabulation of sanatorium results. The results would vary according to the class of patients treated in a sanatorium, or according to the stage of the disease, the first stage cases yielding better results than advanced ones; or according to the duration of treatment, the longer the duration the better likely to be the results. Also the results may vary not only in different countries, but in the same country in different places as reported by different men. While Professor Winslow,[1] of America, puts the sanatorium cures as low as 25 per cent., Hoffmann says[2] that, at the Loomis Sanatorium, New York, out of 1,290 cases successfully traced to October 31, 1918, 1,141, or 88·5 per cent., were reported alive. Again, Ostenfeld,[3] of Denmark, from a working-class (Faksinge) sanatorium, says that 44 per cent. of 1,278 patients were fit for whole or part-time work after five years, while Saugman,[4] Denmark, speaking of a well-to-do (Vejlefjord) sanatorium, estimates that 50 per cent. were fit for work after five years. These results, read side by side with those of Dr. W. H. Dickenson,[5] of Newcastle-on-Tyne, who says that out of 1,162 cases 797 died, and only 81 are now working and fit for work, show that any attempt to compare the statistics of different sanatoria which yield different results in different years will only lead to confusion and error. Another source of inaccuracy of results arises from the inability to trace a good proportion of ex-sanatorium patients. For these and many other reasons it is impossible to draw anything but general conclusions from sanatorium results. At any rate, with regard to our own experience, we think more accuracy can be obtained by keeping to general statements.

Exclusive of short stayers, we had treated 1,014 patients till August, 1921. Taking together patients of all stages, 56 per cent. left the sanatorium with the disease arrested and fit for work. Enquiries of old patients, made two years or

so after they left the sanatorium, showed that some had gone abroad, others had changed their residence, while some others did not care to reply as they did not want to be reminded of their sanatorium past. So that the returns are necessarily incomplete. From what we do know we conclude that the percentage has dropped from 56 to 48 after two to five years. Analyzing the stages, about 80 per cent. in the first stage, 40 to 45 per cent. in the second stage, and 8 per cent. in the third stage got well. Even these percentages are not free from error, as some early cases merged into the moderately advanced, and these into the advanced stage, so that no sharp line could be drawn between them for statistical purposes. Also some apparently bad cases did better, and some early cases did worse than was expected, so that classification and prognosis made when they entered the sanatorium did not always coincide with what actually occurred afterwards.

Speaking generally, a little more than half the patients of all stages that entered the sanatorium recovered. The first stage patients formed the vast majority of the arrested cases. The earlier a case was treated the more satisfactory and permanent the result. The patient's own dynamic energy and will power play a more important part in the course of the disease and after-results than the stage in which he entered the sanatorium. The physician and the sanatorium can only help to bring out the healing energies lying latent within him; but it is on the patient's own inner resources that the arrest of the disease ultimately depends. There is no definite relation between the quantity of tubercle bacilli in the sputum and the extent of the disease in a patient. His clinical symptoms are a surer index of his tuberculous condition than the presence or absence of tubercle bacilli. Our own experience agrees with Sergent[6] when he says that even tubercle bacilli in the sputum do not necessarily prove that the lesions are in process of evolution, and that the absence of tubercle bacilli is not an unfailing testimony as to the non-activity of the lesions.

It may be argued that some of the successful sanatorium results are due to spontaneous cure, and that the patient would have got equally well without any treatment at all. True, but we think that sanatorium treatment has made nature's arrest more sure and certain in many cases. On the other hand, every sanatorium can record cases which, but for the systematic and timely care and help given by the sanatorium, would have succumbed to the disease. Let me give one or two instances. As I write, an old patient from Swansea paid us a surprise visit. His case is interesting. He entered the sanatorium in 1904—seventeen years ago—while he was twenty-five. He was riddled with tuberculous disease. He had tubercle of one testicle, of ribs, sternum, and hip. In 1903 the affected testicle was removed, and many times he was operated upon for caries of ribs, miliary abscess of sternum, and psoas abscess. He was with us for seven months. In spite of his low resisting power and tuberculous constitution he made a splendid recovery. He married about nine years ago, and is now doing well and working hard, and taking an active part in looking after his fellow-employees.

Writing of this case one is reminded of another patient from the same neighbourhood—a young lady who was with us in 1902 for seven months, and got well and married, and has two fine boys, whose photographs will be found facing page 363. A month ago a French teacher came to be re-examined at the sanatorium. She was sent by Dr. Chapman, of Hereford. Hers was a bad case. Both her lungs and throat were severely affected. She could not speak for months, and was often in bed with high temperature. Many times we were at the point of sending her home. But she persevered, and wore the mask practically day and night, and after twelve months or so her voice gradually came back, the temperature became normal, the disease in the lungs showed signs of arrest, and eventually she returned to her old work of teaching French in a girls' school. A patient left us in June this year—a shipping clerk—aged thirty-two, from Woodford, near London. Both his lungs were affected

front and back—the left more so than the right. His pulse and temperature—pulse more than temperature—kept high for many months, but pluck, and perseverance, and treatment, succeeded in arresting the disease, and after a stay of thirteen months he went home last month to resume his duties. Another patient—an Excise Officer, from Devon—came to see us on his way for his holidays. He was admitted in 1911, was a hæmorrhage case, made a complete recovery, was married in 1916, and has a fine healthy child, whose photograph is shown facing page 362. So we could add many more cases. Memory brings back a case from Ireland—a mother with six children, who was troubled with incessant cough and copious expectoration; one from Canada, who had both her lungs and larynx affected, and who married a Canadian officer, and is now helping him on their own farm; one in India who was a medical student, since qualified and in practice; one in New Zealand; another in France; and another in Buenos Aires. Most of these cases were in a moderately advanced stage when they entered our sanatorium, but made excellent recovery. These and similar cases from other sanatoria are standing witnesses to the great work done by sanatoria all over the world. If they saved only 25 per cent. of cases, as Professor Winslow stated, they are worth while from every point of view, and their existence would be amply justified, as Billings and Hawes[7] have proved after careful enquiry into many sanatoria.

Duration of Treatment.—The length of stay required to bring about recovery is about six months in the early stage (the shortest time being about five months), nine to twelve months in the moderately advanced, and two winters and a summer in the advanced stages. The duration of the treatment has a very important bearing on its success. It is utterly absurd to expect, as some have done, to cure a patient, or even arrest the disease, in three months. There is no doubt some truth in the insinuation that the patients who have been partly patched up by the open-air treatment, and return to unhealthy surroundings, relapse more quickly than those who have remained in the old conditions of life,

simply because half a cure is worse than no cure. A creaking door lasts longer if left alone, because everyone knows its deficiency, and uses it carefully; but it looks strong when it is half mended and painted, and the first careless knock breaks it to pieces. Hoffmann[8] thinks that the 'American sanatorium experience has yielded better results with a lower death-rate and a larger rate of effectiveness for work than either the English or German experience,' because, for one thing, the average duration of treatment in America is very much longer than the average length of stay granted to insured patients in Great Britain.

Causes of Failure.—The causes of failure of sanatorium treatment are mainly due to—

1. Medical men not sending their cases at an early stage.
2. Patients who at the first sign of return of health go home thinking they are cured.
3. Institutions which cannot keep patients for more than two to four months, and then send them back to their former unhygienic surroundings.
4. The social, economic, and hereditary evils have often overwhelmed and neutralized the good effects of sanatorium treatment.
5. The tendency of some sanatoria to relax all rules and discipline and run them on lines of an hotel where patients can eat, drink, and practically do what they like. Such establishments have brought discredit upon the whole sanatorium movement. Still there has been much unfair criticism on the results of even properly conducted sanatoria by those who judge from the narrow view-point of statistics and cured cases, and who show no ability to assess the right value of things or take a broad outlook of the work of sanatoria.

In spite of many years of vigorous propaganda and the advanced knowledge of tuberculosis we do not get many incipient cases for treatment. The early cases we see are generally recrudescences of old lesions that have been lighted up by physical and mental strain. In fact the widespread agitation against consumption and compulsory

notification have made matters worse in this respect, and have scared the people from seeking early advice and treatment. Again, we are now living in very strenuous times. We have often poor material to work upon in our patients. The strain and stress of the great war, the world's unrest, the social, economical, and financial difficulties of the nation, the high cost of living, the increasing burdens of life, have all tended to undermine the physical and nervous condition of the people, and have aggravated the state of the disease, so that patients do not respond so readily to sanatorium treatment as they did before the war. You do not expect a builder to build a palace out of a few bricks and mortar, nor do you blame the surgeon for not curing every case of cancer by operation; so the blame for poor results cannot be laid at the door of sanatorium treatment, the principles of which are sound enough and perfectly rational and physiological. What is wanted is not less but more and extended sanatorium treatment applied intelligently and strictly to every individual case in as early a stage as possible.

Further, time is an important factor in the successful treatment of consumption. Patients often delay treatment for many months after the disease is diagnosed. When the disease gets a strong hold, as seen by the soft and rapid pulse, the hectic temperature, the steady loss of flesh, anorexia, and diarrhœa, the treatment will not avail much.

The most important cause of failure in our experience is that patients either have no means to continue the treatment for long, or have not the patience to persevere in the sanatorium régime. At the first sign of return of health, they leave the sanatorium and seek more congenial surroundings. Rigid discipline, cold, absence from home and friends, etc., are unpalatable, and it is most difficult to convince patients that health can only be got back at a great sacrifice—that Nature demands strict conformity to her laws. It is one of the signs of this decadent age that patients have not the strength of character or stamina to stand fast, and strenuously continue in the fight with the disease.

We go further, and say that the question of arrest of the

disease is more a matter of a patient's perseverance in the treatment than even whether he comes under treatment at the first, second, or any stage of the disease. This may be a bold statement to make, but nevertheless it is our experience. Over and over again we have known patients who came to the sanatorium in the early stage, and who returned home too soon, partly patched up, with the result that after a few months they succumbed to the disease. On the other hand, we have known others who came to be treated in the cavity stage, and with very little resisting power, but who have persevered for two or three winters, and are living now to testify to the efficacy of the open-air treatment. Of course, we exclude from present consideration those cases which seem to go wrong from the very beginning, and which get steadily worse in spite of every care and attention. We do not understand at present the laws that underlie these cases; some day we shall. We also exclude those cases in the advanced stage where gastric functions are deranged, and the process of assimilation and excretion is poisoned by toxins and other products of pathogenic organisms. But apart from these cases, broadly speaking, the failure or success of the treatment depends more or less upon the patient himself. In other words, the amount of vitality and fighting force determine the prognosis of almost every case. The sanatorium treatment increases the resisting force of the patient. If he perseveres in the treatment, there is every probability of his increasing his vital force and of overcoming the disease sooner or later.

Lastly, the enormous educational value of a sanatorium has been lost sight of by the sanatorium critics. The sanatorium, like the Evangelist in the 'Pilgrim's Progress,' points out a new way of life to patients and their circle of friends and relatives, who in their turn spread the gospel of fresh air to a still larger circle of friends and acquaintances till the leaven of the open-air teaching permeates the whole community and nation.

The success of the open-air movement is not merely to be gauged by the number of lives it has been the means of

saving, but in a greater degree by the way in which it opens up larger issues, and rouses the nation to see the evil tendencies of modern thought and modern life, suggesting reforms along national, social, and municipal lines. The sanatorium treatment is only a part of a great movement which aims at going to the root of the matter. Like the ever-widening circles caused by a stone dropped into a still lake, it tends to widen the outlook and extend its reforms from one disease to the prevention of all disease, and will never rest till it has taught the nation to regard the health of its citizens as a sacred heritage, which it should guard at all costs and against all enemies. Looking thus from a broad point of view, the sanatorium treatment can never be regarded as a failure.

Sanatorium versus Home Treatment.—It is not impossible to pursue successfully the open-air treatment at home, where especially the well-to-do can secure the best hygienic conditions with medical supervision; but for the majority of the people it has many drawbacks as compared with a sanatorium, where all the improved means and facilities are available to carry out the treatment to the fullest possible extent. (1) It is better for the patient to be treated away from home. The change of air, the change of surroundings, the absence of unwise and mistaken sympathy of friends and relatives, who are apt to interfere with the treatment by frequent visits and wrong advice, all make it desirable for the patient to be removed to a sanatorium. (2) In how many private families is it possible to obtain the conditions necessary for the successful carrying out of the treatment—viz., a house in the country, situated on a dry soil, away from dust, smoke, and noise, with protection from winds, which has a garden large enough for the erection of a shelter where the patient can take his rest in quiet and privacy from the intrusion of neighbours? (3) Even if the necessary conditions are forthcoming in a private house, without medical supervision they are of as much value as a sumptuously appointed ship without a captain to guide it. And how few will have the courage to go steadily and faith-

fully through the daily routine, and take their exercise and keep the hours of rest, and forgo the visits of friends and relatives, week after week, and month after month! When a person is struck with a mortal disease his nervous system is undermined and his will weakened, and he requires the gentle guidance of a strong hand to advise and help him over the crisis. Of course, the nature of the disease may be such that it may not be possible to remove the patient from home, or the illness may be so slight that home treatment may be considered sufficient. But in all cases where the disease is pronounced, and the patient is fit to travel, and where speedy arrest of the disease is an economic necessity, a well-conducted sanatorium offers the best prospect to a large number of people.

Climate.—A great deal of confusion exists among medical men as to the advantages offered by climate in the treatment of tuberculosis. Some make extraordinary claims of the benefits of climatic treatment, while some go to the other extreme and affirm that it has no influence whatever on the course of the disease. These contradictory views show an inability to assess the right value of the various factors that enter into the treatment of consumption. For instance, taking, roughly speaking, the four chief factors according to their relative importance, one finds that the patients' resisting power has a more favourable influence on the arrest of the disease than food. Food is more important than fresh air, and pure air, free from dust, is more important than climate; so that when good results are claimed to be obtained in a great many climates, it is because one or more of the first three factors are forthcoming. That even the third factor (pure air) is not so important as the first two is seen by the fact that many recoveries from consumption take place in such smoke and dust laden districts as Sheffield in England, and Pittsburgh[9] in America. Nevertheless, the clinical experience of many sanatoria supports Trudeau[10] when he states that hot weather is unfavourable to phthisical patients, and the greatest improvement takes place from early fall to early spring of the year. The very

fact that patients show greater improvement during certain seasons of the year is a strong proof that climate does exert an influence in the progress and treatment of consumption. The benefit of climate is, to a great extent, due to its psychological influence. Having had sanatoria both near the vicinity of the sea and at an altitude of nearly 850 to 900 feet, we can speak from practical experience that a moderate elevation ensures cool air, an element of rarefied atmosphere and increased metabolism, and thus has a distinct physiological value. Owing to strong winds, atmospheric humidity, and low altitude, consumptives are not permanently benefited by residence near the sea. They do well for a time, and then they either remain stationary or go back in health. Extreme heat, or cold, or dry, or moist conditions of atmosphere have a depressing and devitalizing influence on the patient, and therefore should be avoided. The study of the death-rate in the light of climatographs[11] has shown that cold waves of weather (not continuance of low temperature), or an alteration of temperature from hot to cold, or the reverse, appear to be decidedly favourable to health; that warm dry weather does more harm than warm wet weather; that people of all races enjoy best health at 64° F.; and that a variable climate is in general much more healthful than a uniform climate, even though the latter has an almost ideal temperature.. This may, perhaps, be the reason why many consumptive patients do well in England, with its variable climate and humid atmosphere. At any rate, a dry and equable climate is not necessary, even if it be not injurious in the treatment of early cases, though in the late stages of the disease, with low vitality and copious expectoration, some patients do better in warm, fairly moist, and equable climate. The sun is Nature's best tonic. To be healthy and happy we should seek the sunlight as plants do; and yet the beneficial effect of sunshine in the treatment of consumption is rather exaggerated. In tropical countries the sun's rays do not prevent the disease from taking a rapid course. On the other hand, in Finland[12] the average winter sunshine is two

hours, and yet the sanatoria there get better results during the eight months of cold weather than in the four hot months when they have sunshine all the time, because nutrition is better in the colder weather. On the whole our own experience is that heat is debilitating, and cold is beneficial in pulmonary tuberculosis; that consumptive patients do better in elevated country districts than near the sea, and their nutrition and improvement are more marked in cold winter than hot summer.

High Alpine stations, such as Davos (5,000 feet), Arosa, St. Moritz (6,000 feet), are recommended for the purity of air and large amount of sunshine, and for dry, cold, and rarefied atmosphere. It may be advantageous for well-to-do patients in the early stages of the disease to carry out the treatment on the Continent, where better weather conditions and more sunshine would induce them to spend a large part of the day out of doors; but the distance from England and home and friends, the want of adequate medical supervision of patients living in Alpine hotels, the temptation to join in the sports and take a greater amount of exercise than is good for them, are disadvantages which may outweigh the benefits offered by these elevated districts. Besides, one finds that some patients do not seem to do so well when they return home from these resorts. We think that patients who live and have their family and business connections in this country are better treated at home. The cure or arrest effected in England, with its uncertain and variable climate, is more satisfactory than where the climate is more mild and favourable. But whether treated at home or abroad the one condition for success, beyond climate and altitude, is strict and faithful compliance with the principles of the treatment as indicated in previous chapters. When once the disease is arrested, the patient will be greatly benefited by a change of air to the seaside, or a visit abroad, or a short sea voyage when it is possible to remain on deck the whole of the time. A long sea voyage which compels the patient to spend his time in a stuffy cabin with one or more passengers would nullify all the good effected by the treatment, and is strongly to be condemned.

The After-Care of Sanatorium Patients.—When the disease is more or less arrested, and the patient leaves the sanatorium, he enters the convalescent period, when he will be faced with many anxious problems concerning his future career: Will he be able to resume his old occupation? Is there any risk to his health if his old office and home surroundings are bad? If his former work is uncongenial, can he take up some new occupation? Is it advisable to emigrate to some foreign country in search of more suitable work and climate? To those who are provided with ample means and can afford to rest or go away for a change before resuming any work, the problem is easy. But the majority of patients who leave the sanatorium are the bread-winners of their families, and therefore they must return to work to provide for those who are dependent upon them; hence the question of choosing the right kind of employment, and of maintaining their health is a very real and pressing problem. At this stage of after-care the patients should be warned of two dangers: (*a*) Of following the strenuous work of pre-sanatorium days; (*b*) of leading a lazy life, doing nothing after they leave the sanatorium. We advise our patients when they return home to avoid all excesses, crowded places of amusement, late hours, to go to bed early and take plenty of rest, and carry out the sanatorium treatment as far as possible. They are also advised to move away from city surroundings, and choose a healthy suburb to live in; if they are employed in London, they will have a choice of such places as Northwood, Harrow Weald, Hampstead, Highgate, High Barnet, etc., in the north, and among Surrey hills, Epsom, Caterham, Woldingham, Oxted, Limpsfield, etc., in the south. Or they can go farther away in the country, such as in the neighbourhood of Amersham, Great Missenden, High Wycombe, or the Chilterns, Harpenden, Letchworth, etc., in the north; Dorking, Leith Hill, Haslemere, Hindhead, East Grinstead, Crowborough, etc., in the south. It is best to avoid a long, tedious railway journey, to walk four or five miles a day while going to and fro to business in preference to riding on the bus, tram,

or train all the way. As for the idea of going abroad, we advise the patients to remain in England at least a year after the arrest of the disease is fully established before they make a change.

If the old occupation involves working late and long hours and in close and stuffy surroundings, the question of taking up some new work where the patients would lead a more healthy and open-air life will have to be seriously considered. While it is true that returning to hard and strenuous work in confined buildings and to unhygienic home life is a fruitful cause of relapse, it is also true that old occupations offer many advantages, and consumptives often do better when they return to them, provided they are not very bad or injurious. Besides, poor food is more often the cause of breakdown among ex-sanatorium patients than their poor home surroundings.

It is our experience that the working capacity of a patient in whom the disease is arrested is not as great as his former capabilities, and that it is not possible for him to compete on an equal economic footing with his healthy fellow-workmen. He ought not to work more than four to six hours a day for at least six months to a year after the disease has been arrested. Of course the economic necessity may override the physician's recommendations, and hence some intervention of the State may become necessary to make up for any losses the patient may sustain by working shorter hours, to provide some after-care schemes such as labour colonies, to initiate the building of cottages and houses on the outskirts of big cities and towns—all of which involve broad issues, and the consideration of political, social, and municipal authorities.

(*b*) On the other hand, in the best interests of the patient and of those around him, it is important that he should be encouraged to do some work to keep his mind engaged, to regain his interest in life, to get once more into touch with the affairs of the world, so that he may not find time to brood over his former illness. Idling away his time doing nothing is both physically and psychologically injurious to the patient, as it enables him to dwell on his morbid auto-suggestions

and makes him afraid he will never be fit to work again. Long-continued unemployment will cause him to lose interest in himself and others, and the inclination to do anything. Whereas work will act as a mental stimulus, give him new energy and strength to look after his family, to overcome difficulties and to put a finishing touch to the arrest of his disease.

To meet the extreme dangers of overwork and no work, to help the patient with the best advice in the convalescent stage, and to look after the home and the family when he is away at the sanatorium and after his return, some organization, such as an after-care committee, may be found necessary, which would consist of the tuberculosis officer, the unemployment bureau, and the voluntary efforts of church and social agencies of the neighbourhood. But the tendency of these committees is to surround themselves with rules and regulations, to treat cases in a mass, to lose the human touch and warm sympathy for individual patients. For those other than the working classes, who could be more eminently fitted to offer the right kind of advice to the patient than his own medical attendant and the physicians of the sanatorium where he was cured or his disease was arrested? These knowing the exact condition of his lungs and constitution from constant observation, the amount of progress he made, the working capacity which he possesses, in fact their intimate acquaintance with his case, would enable them to offer the best advice as to his future career. The sanatorium would thus become not only an educational and healing centre, but also an advisory institution for the after-care of patients and help the tuberculosis officer and the family physician in looking after the welfare of the patients for at least six months to a year after they leave the sanatorium.

But after-care schemes, advisory centres, relief committees and such like measures, do not touch the main problem—the prevention of tuberculosis, which is inextricably mixed up in the wider consideration of the social, economic, industrial, and political life of the people, which we shall proceed to study briefly in the third part of the volume.

REFERENCES.

[1] Winslow at the International Conference on Tuberculosis, London July, 1921.

[2] Hoffmann, *Tubercle*, February, 1921, p. 211.

[3] Ostenfeld, *Tubercle*, July, 1920, p. 469.

[4] Saugman, *ibid.*, p. 471.

[5] Dickenson, *Tubercle*, February, 1921, p. 211.

[6] Sergent, *American Review of Tuberculosis*, vol. iv., 1920-21, abstracts, p. 150.

[7] Billings and Hawes, 'Are Sanatoria Worth While?' *American Review of Tuberculosis*, vol. i., 1917-18, p. 668.

[8] Hoffmann, 'National Health Insurance and the Medical Profession,' *Prudential Press*, U.S.A., 1920.

[9] Pittsburgh, *American Review of Tuberculosis*, vol. iv., 1920-21, p. 220.

[10] Trudeau, 'Climate in Pulmonary Tuberculosis,' by John W. Flinn, *American Review of Tuberculosis*, vol. iv., p. 301.

[11] 'Interpretation of the Death-Rate by Climatographs,' *Modern Medicine*, May, 1919, p. 13.

[12] Finland, *American Review of Tuberculosis*, vol. iv., pp. 231 and 232

CHAPTER XX

HÆMOPTYSIS

Of late years profuse hæmoptysis, threatening the life of the patient, is not so common in sanatorium experience. It may be because the patients are taken in hand earlier, and the sanatorium treatment tends to build up their strength, quicken the healing process of the lung, and arrest the disease before any serious erosion of a bloodvessel takes place. In fact, the treatment on open-air lines has more or less completely modified many of the classical symptoms of consumption, such as hæmoptysis, night-sweats, pyrexia, etc. Excepting where the hæmoptysis occurs from the rupture of an aneurism or of an arterial vessel during the last stages of tuberculosis (of course, I exclude all those hæmorrhages caused by mitral disease, aortic aneurism, tumours, hæmophilia, etc.), the majority of cases that are seen in a sanatorium are amenable to treatment, and need not cause serious alarm. When hæmoptysis occurs during the early periods of the first stage, and the physical signs are practically nil, it is due to passive congestion of small veins and capillaries of the bronchial mucous membrane. The bacillary theory does not satisfactorily explain the presence of hæmoptysis in early cases, as tubercle bacilli in the incipient stage do not take a prominent part, if they take any part at all, in spontaneous disease. A more rational view, as already observed, seems to point to an alteration in the quality of blood, some defect in the proteins of the blood, and consequent loss of resistance in the red cells brought about by nutritional or constitutional disturbance which leads to swelling of the intima of small pulmonary veins, stasis, congestion, and extravasation. So that the escape of blood in early phthisis can be

explained as a part of the process of the organism to meet the defective condition of the blood and the system. Many early cases of hæmoptysis do well and recover. Besides, the hæmorrhage so alarms the patient that he immediately seeks medical advice, which otherwise he would not do, and goes for a change, or undertakes a course of sanatorium treatment. Thus many a life is saved by the timely warning of Nature.

Often these early cases of hæmoptysis present little or no physical signs, and no cough, expectoration, or temperature. Even a slight impaired movement, or one or two clicks in one of the apices, may be absent, and the physician is apt to make light of such cases, and attribute the source of hæmorrhage to the nose or throat. Of course, a varicose vein at the back of the pharynx is a probable though a remote contingency (the writer has had only one such case), and the diagnosis becomes extremely difficult when hæmoptysis is accompanied by indefinite and almost negative symptoms. But the writer's experience makes him say that it would be wise for the physician to treat all such cases (after excluding all other possible source of bleeding) with suspicion, and give the patient the benefit of the doubt, and send him away for a change, or for immediate treatment for a few weeks. By this course he will free his conscience from all future blame or responsibility, and at the same time help the patient to renew his health and strength. Sometimes, before or during sanatorium treatment, the morning sputum is stained from spongy or bleeding gums, or from a congested throat when the patient begins to cough and expectorate, and should not be confounded with hæmorrhage from the lungs. At other times the patient persists in bringing up a little blood, or the sputum is stained for several days, especially in the morning. This may be due to healthy inflammatory reaction or be a sign of a healing lung, which, like a granulating wound, is well supplied with blood, and inclined to bleed from simple hyperæmia. Or the oozing of the blood in the morning, seen in some early cases with anæmia, and poor nutrition (bringing about a defective condition of the blood), ceases

entirely when they are placed under fresh air and nourishing food. On the other hand, in some of the sanatorium patients who respond to the treatment quickly, and who, by doing full justice to the diet, make blood rapidly, the hæmoptysis need not cause much alarm. Their full-blooded and plethoric condition is brought about by high feeding, and the hæmorrhage is more beneficial than otherwise, as it acts like a safety-valve to the congested vessels. Such cases do well when the diet is restricted, especially meat, and the quantity of milk is reduced to a half or one glass a day, and the patient is put gradually on to more exercise when the bleeding has stopped. The writer has noticed cases of hæmoptysis occurring in some women patients during their menstrual periods, when a kind of tide flows over the whole body, including the lungs. This tide may increase the blood-pressure for the time being, and may find out a weakness in a bloodvessel, causing hæmorrhage. The writer had a patient who for several months had attacks of hæmoptysis at the time of her monthly periods, and sometimes replacing them. It is possible for the hæmorrhage, or vicarious menstruation as it is called, to occur without any lesion in the lungs; but should there be a weak spot in the pulmonary organs, it is more likely to show itself there.

Treatment.—An attack of hæmoptysis generally terrifies the patient, and the physician, to allay his fear and distress of mind, is tempted to step in and stop the hæmorrhage in all cases. But he should bear in mind that in so doing he may be interfering unnecessarily, and thus working contrary to Nature's purpose. Hæmoptysis may be due to increased blood-pressure or to the erosion of a bloodvessel, or to both, the increased pressure causing a rupture of a vessel already weakened by tuberculous disease. Small hæmorrhages may be useful, and be a blessing in disguise. It may be Nature's way of relieving undue tension in the systemic arteries. Hæmoptysis will be found beneficial in two ways: (*a*) It reduces the blood-pressure, thus arresting hæmorrhage; (*b*) the effusion of the blood in the lung may be used by Nature as a means of bringing about the arrest of the disease by causing inflammatory reaction and formation of fibrous

tissue. Therefore the sanatorium experience gives the physician a certain amount of boldness and freedom in the treatment of hæmoptysis. While he keeps a watchful care over such cases, he is not unduly alarmed, nor does he seek to stop every attack with hæmostatics. In some cases a recumbent position with the head and shoulders slightly raised by pillows seems to be most advantageous; in others a reclining attitude seems to be most beneficial; while in some others a more or less upright position helps to get rid of the blood-clots. The best position seems to be that which is most comfortable to the patient, and most easy for the removal of clots, and least prone to dyspnœa. In a great many cases the prognosis is favourable. If the hæmorrhage is small, and the patient's strength is good, rest in bed and a low diet may be all that is necessary. If the hæmorrhage is persistent and troublesome, absolute rest in bed and quiet is enjoined, the patient being kept free from all excitement, and his strength maintained with low but nutritious diet. In serious cases of hæmoptysis, followed by fever and exhaustion, the patient should be fed day and night, and the diet made as nutritious as possible with milk, raw eggs, etc.

Drugs.—In the writer's experience there are only two remedies that are both safe and reliable in hæmoptysis—*i.e.* morphia and nitrite of amyl. Even morphia should not be given indiscriminately or as a routine practice, as it tends to lower the sensibility of the bronchial and alveolar walls and to favour broncho-pneumonia. If the cough is troublesome and irritating, and the patient is in a restless and agitated state of mind, a hypodermic injection of ¼ grain of morphia lowers the blood-pressure, quiets the action of the heart, and allays the patient's fears If the tension of the blood is great in spite of the bleeding, and hæmoptysis is profuse, nitrite of amyl in 3 to 5 minim capsules, inhaled, acts very beneficially, and stops the hæmorrhage in many cases. But it should be used with care, and tried only after morphia has failed to control the hæmorrhage. The writer has found no help in drugs like chloride of calcium, ergot, adrenaline, etc. The adminstration of ice, either internally or externally, is of no use, and should be discarded.

CHAPTER XXI

LARYNGEAL TUBERCULOSIS

LARYNGEAL tuberculosis is, in nearly all cases, secondary to tuberculosis of the lungs, although in a very small proportion of cases it seems to occur primarily. It is an extension of the disease from one or both apices of the lungs. It affects more than others those who employ their voice in their daily vocation, such as teachers, singers, etc. Though it is a serious complication of pulmonary tuberculosis, the outlook at present is not so gloomy and hopeless as it was to physicians of some thirty years ago. The open-air treatment, combined with early diagnosis and complete rest to the voice, have modified the gravity of the prognosis of old days, and have brought a bright ray of hope to the unhappy sufferers from the disease. Tuberculosis of the larynx is more common than was once supposed. Even in the early stage it affects 10 to 13 per cent. of cases of pulmonary disease, the frequency steadily rising to 40 per cent. in the advanced stage. Fifty per cent. of post-mortem examinations of phthisis show disease of the larynx. About 18 to 25 per cent. of all patients entering our sanatorium had laryngeal complication. Though it is generally held that men are more predisposed to this disease than women, we agree with St. Clair Thomson[1] that there is not much difference in the incidence between the sexes. The symptoms begin in a slow and insidious way. The patient complains of an ill-defined pain about the throat, his voice gets tired and husky after speaking or singing; then it gets hoarse during some part of the day. In anæmic women there may be more or less complete aphonia. The hoarseness or aphonia disappears for a time, thus deceiving the patient and the physician as to the true nature of the case. For the hoarse-

ness returns after a while, and becomes progressively permanent with the increase of tubercular mischief in the lungs. In some cases the loss of voice is the only symptom the patient complains of when he sees the physician, or when he enters a sanatorium—in which case the lung mischief is either masked or in a state of temporary quiescence. In other cases the disease may be present in the larynx without affecting the voice, and the patient does not suspect there is anything wrong with his throat till after the vocal cords are involved. Clinically we recognize three stages of the disease:

(*a*) Patient run down in general health, voice hoarse or weak, sense of fatigue after speaking or singing, simple laryngeal catarrh (generally bilateral), slight cough and hoarseness, signs of early mischief of one or both apices, little or no sputum, temperature and pulse a little above normal or subnormal, appetite good, no pain or difficulty in swallowing.

(*b*) Laryngitis is more pronounced; unilateral swelling of either one of the vocal cords—more frequently the posterior part; the cords look pale, greyish, and flabby; slight ulceration of the epiglottis or ventricular bands; thickening of one or both arytenoids, loss of voice more marked, lungs more severely attacked, cough and sputum present; rise of temperature, which sometimes may be normal; pulse frequent, digestion good, appetite fair; there may be a slight difficulty in swallowing hard food or no difficulty at all.

(*c*) Destruction of the cartilage, ulceration of cords, loss of voice complete, lungs greatly involved (cavity stage), temperature high and pulse rapid, irritable and distressing cough and copious expectoration and disturbed nights, appetite bad, and pain and difficulty in swallowing.

Prognosis and Treatment.—As in pulmonary tuberculosis there is a certain element of uncertainty in the prognosis of laryngeal disease. We cannot always reckon an early case will do best, whereas extensive ulcerations of the larynx sometimes heal up and surprise the physician. It is well to remember that hoarseness arises very frequently in very early tuberculosis, and may be more often due, especially in

women, to a loss of tone in the nervous system than to any tubercular mischief in the throat. On the other hand, tuberculous lesion in the larynx does not always cause hoarseness and discomfort. Generally speaking, the prognosis very much depends upon the extent of the trouble in the lungs, and we have found from experience three things essential for the arrest of the disease: (1) Early diagnosis and early treatment, (2) complete rest to the voice, (3) continuous inhalation. Accordingly, our patients are treated on the following lines:

1. Early detection of the disease is very necessary, so that the patient may be sent to a recognized sanatorium for prompt treatment. In all cases of hoarseness, however slight, the lungs should be examined and the patient kept under observation. It should be borne in mind that laryngeal affection is only a local manifestation of pulmonary disease, and that when the patient submits to treatment he is very often run down in health with his nervous system more or less impaired in tone. So all patients with laryngeal complications are placed under the best possible hygienic conditions, and their general health and nutrition improved by various items of sanatorium treatment. They spend a great part of the day in the open air, which has a soothing and healing influence on the throat. Patients in the first stage carry out the various exercises except singing, and take their rest like the other patients. If the temperature goes up they rest in bed, which in fine weather is wheeled out on the veranda, and kept there day and night. The patient takes the ordinary diet in the first stage; in the second stage he is not allowed to eat anything hard like breadcrust, or anything hot or pungent; in the third stage the food is given in semi-liquid form, more or less cold, as patients manage to take cold food better than hot. All condiments, sauces, spicy dishes, or anything that would give pain, are prohibited.

2. The beneficial effects of the silence treatment have been so marked in our sanatorium experience that it is used more or less as a routine treatment in all cases where the larynx is

affected. The more thoroughly it is enforced the more sure is the success. The patients are more or less isolated, and are encouraged in every way to keep silent, and to communicate with others by writing in a note-book. All smoking is prohibited. They go for their walks alone. All these measures may, after a time, entail a certain amount of hardship and inconvenience to the patient, but the constant encouragement of the physician, together with the improvement in himself and in other patients, inspires him with hope, and makes it easier for him to persevere in the treatment until he gets well. It is needless to say that it is not possible to carry out the silence treatment at home. Hence the great value of an institution like an open-air sanatorium in the treatment of laryngeal cases. As the voice improves and hoarseness ceases, the patient is gradually allowed to converse in a whisper, and then to talk a little, and finally full liberty is given when he is completely restored to health.

3. **Continuous Inhalation** relieves the cough, checks laryngeal catarrh, protects the patient from wind and dust, keeps him from talking, and ensures a complete rest to the voice. The patients keep on the author's inhaler practically day and night, using C or D mixture, which contains guaiacol, iodine, terebene, menthol, and pumilio pine, mixed with chloroform and rectified spirit (see p. 273). They do not at first use A or B mixtures, as the formalin they contain may tend to irritate their throats, but they do so after they begin to improve. The volatile vapours reach the larynx very quickly and directly, and thus benefit the affected parts by their soothing and antiseptic action. The inhalation treatment has probably no specific action on the tubercle bacilli, but there is no doubt it subdues the inflammatory condition, and helps to bring about recovery by checking the spread of the disease to healthy parts and preventing their infection by pyogenic organisms.

Many early cases get well under this combined treatment. The prognosis is hopeful even in the second stage if the patient carries out the treatment perseveringly and in strict silence. In the third stage very little can be done beyond

soothing the cough by inhalations. If the cough is still persistent, heroin is given. To relieve pain in swallowing, Hoffmann, Stewart, Dundas Grant,[2] and Davis[3] recommend the injection of 2 grains of eucaine in an ounce of 80 per cent. of alcohol into the sheath of the superior laryngeal nerve.

Local Treatment, etc.—We believe that all direct local treatment, such as painting with lactic acid, nitrate of silver, etc., curetting, etc., are more injurious than beneficial in laryngeal cases. In fact, we think the patient is best left alone to silence and fresh air. Any surgical interference is not necessary in the first stage, and is useless in the third. In some cases galvano-cautery may be applied with benefit if the lungs show signs of healing and there is little or no sputum. But as long as the lungs are involved, and the patient expectorates a quantity of sputum daily, any operative interference would do more harm than good.

As for tuberculin treatment, while Camac Wilkinson[4] states he has obtained good results, St. Clair Thomson[5] says (and the writer agrees with him) he has not observed any beneficial results. If the sanatorium and silence treatment combined with inhalation fail, the prognosis is bad.

REFERENCES.

[1] St. Clair Thomson, 'Three Years of Sanatorium Experience of Laryngeal Tuberculosis,' *British Medical Journal*, April 11, 1914, p. 801.

[2] Dundas Grant, *Lancet*, June 25, 1910, p. 1754.

[3] Davis, *Lancet*, October 18, 1913, p. 1111.

[4] *Lancet*, April 11, 1914, p. 1039.

[5] Same as reference [1], p. 803.

PART III

CHAPTER XXII

THE SOCIAL AND ECONOMIC FACTORS OF TUBERCULOSIS

'German physicians are beginning to say that tuberculosis should be regarded primarily, not as an infectious disease, but as a disease of nutrition, to be controlled much more by feeding than by preventing infection.'—PROFESSOR KAYSERLING.

'The prevention of consumption involves a much wider issue than the circumvention of the bacillus. . . . The abolition of the corn duties and other free trade legislation, and improved rates of wages, have done more than any notification law against the disease would have been likely to have effected.'—SIR DOUGLAS POWELL.

WHAT has already been written in the previous part of the volume will prepare the reader to go further and examine the problems of tuberculosis in relation to social and economic factors. The tendency of the present day is to study all phases of civilization—industrial, economic, political, moral, and medical—from the standpoint of sociology and psychology. Only life can interpret life. While the speculative theories of science, the researches of the microscope and the laboratory, are chiefly concerned in dealing with the hypothetical problems of dead things, social questions bring one face to face with realities of living beings and their environment. The knowledge of their social relations, the conditions in which they live, and work, and suffer, are human factors which give a truer insight into health and disease processes, and so enable mankind to deal with them more effectually. Before proceeding further, we must know where we stand with regard to the present situation of tuberculosis.

The Present Situation of Tuberculosis.—Sir George Newman,[1] speaking at the International Conference on Tuberculosis held in London in July, 1921, gave an official account of the decline of tuberculosis in this country during the last seventy years, and of the action taken by the State in the prevention of the disease. He said that while the death-rate from phthisis in England and Wales in 1847 was (excluding acute miliary tuberculosis) 3,189 persons per million living, in 1872 it had fallen to 2,384, in 1897 to 1,356, in 1913 to 961, and in 1920 to 842 (standard death-rate), per million living. He further observed that the reduction in the death-rate of tuberculosis, which went with the reduction in the general death-rate, was due to a considerable progress made in sanitary reforms, to improvement in the social well-being of the people, and to general measures introduced by the Government from time to time, such as the provision of sanatorium benefit and more adequate medical service under the National Insurance Act, 1911; the Public Health Acts of 1848 and 1875 down to the Public Health Acts of our own day; the Factory and Workshop Act, 1901; the Workmen's Compensation Acts, 1906 and 1918; the Public Health (Prevention and Treatment of Disease) Act, 1913; the Milk and Dairies (Consolidation) Act, 1915; Public Health (Tuberculosis) Act, 1921; and in addition Maternity and Child-Welfare Service, the School Medical Service, etc. Many of these measures have been directed against tuberculosis in this country. Sir George Newman also stated that in England and Wales there were 341 Tuberculosis Officers, 412 Tuberculosis Dispensaries, and 18,000 beds for tuberculous patients in sanatoria and hospitals, with 3,500 more beds in preparation; and that the complete Government scheme in respect to tuberculosis included Notification, the Dispensary system, Residential Institutions (sanatoria, hospitals, etc.), After-Care work and Supervision of discharged tuberculous patients.

There is no doubt that the decline in the mortality rate had been going on practically in every country advancing in civilization and increasing in wealth as early as 1850

or earlier—*i.e.*, more than thirty years before the discovery of the tubercle bacillus, that tuberculosis had begun to abate its terrors before any strenuous measures had been taken to combat its prevalence. But in spite of official optimism and high ideals entertained by the Ministry of Health, there is another side to the picture which must be studied before we can grasp the real state of affairs.

The Other Side.—The decline in the death-rate of tuberculosis is mainly due to causes that brought about the reduction in the general mortality, and to improvement in the social and economic conditions of the people. Besides, it may also be due to a decline in the fertility (natural and restricted) of the tuberculous as compared with the non-tuberculous families. Perrin,[2] from his observations at a hospital in Nancy, France, concluded (and we are inclined to agree with him) that the non-tuberculous group yielded more than twice as many healthy children (1,862) as did the tuberculous group (876). Notwithstanding the apparent reduction in tuberculosis mortality and the combined efforts of the State, the municipal, the sanitary, and medical authorities, tuberculosis stands as the greatest plague of humanity at the present day, claiming its victims from every clime and country, the rich and poor, the young and the old. The mortality, as Sir George Newman himself admitted, is still extremely high in all civilized countries. Every year the world suffers a loss of at least 5,000,000 people through its ravages.[3] As we have seen, the death-rate in India from phthisis cannot be less than a million every year. In all tropical countries where the disease has obtained a foothold the mortality is greater among the native than among the white population. The death-rate from consumption among the coloured people in the United States is between two and a half and three times that of the white people at all ages, while in childhood and adolescence it is nine and ten times that of the white.[4] In America it is reckoned that one-tenth of all the deaths is caused by this single disease.[5] The report of the executive committee of the American National Tuberculosis Associa-

tion points out that the annual number of deaths from tuberculosis is 150,000[6] (while Hoffman[7] thinks it is 148,000). If, according to the Framingham revelation, there are ten active and ten quiescent cases for every death,[8] there should be about one and a half millions of active and one and a half millions of quiescent cases in America at present (the estimated population of America is 107,000,000). It is stated that in France 850,000 soldiers fell victims to tuberculosis while under military service during the recent war. Consumption supplies 30 per cent. of patients in Paris hospitals.[9] The disease is said to kill almost half the French people between twenty and forty years of age.[10] The German physicians are alarmed at the increased mortality rate of tuberculosis in their country since the great war. Kirchner[11] of Berlin, at the twenty-fifth German Tuberculosis Congress, 1921, said that it has now reached the height of 1,896, or 290 per 100,000 as compared with 137 in 1913.

In 1914 the tuberculosis mortality in 380 German towns of over 15,000 population was 41·7: in 1915, 44·8; 1916, 48·8; 1917, 67·9; 1918, 74·0.[12]

In a house-to-house visitation at the homes of 1,017 poor families in Trier, Germany, it was found that 379 families had some member suffering from tuberculosis; there were 343 cases of tuberculosis, 249 of scrofula, and 43 other forms of tuberculosis.[13] In 1910 there were 18·73 deaths from tuberculosis per 10,000 children of school age, while in 1919 there were 41·32 (more than double). In the former Austria-Hungary the rise of the phthisis death-rate is greater than in Germany. In Vienna it was 286·8 in 1914, and 405·2 in 1917. In Budapest it was 340 in 1914, and 470 per 100,000 in 1917.[14] While among young men the increase of mortality was 113 per cent., in children it was 186 per cent.[15] In Vienna, in 1913, the deaths from tuberculosis numbered 6,430; in 1914, 6,233; 1917, 11,741; 1918, 11,531; 1919, 10,606.[16] The neutral countries bordering upon Germany also show an increased tuberculosis mortality, especially Denmark, and, to a less degree, Holland and Switzerland, while in Sweden and Norway no increase has been observed.[17]

In Italy, the land where compulsory notification and segregation were enforced for many years more than two hundred years ago, tuberculosis claimed (1906) 1,657 per million, while all the zymotic fevers, malaria, and pellagra put together did not amount to 1,019 per million inhabitants.[18] Stouman,[19] giving the returns for twenty-six principal Italian cities, says that the phthisis rate increased from 1,666 in 1914 to 2,555 in 1918 per 100,000. Greece reports a percentage of 31·60 deaths (1905-1907) out of every 10,000, thus taking precedence of other European countries and America.[20] A survey by American Red Cross doctors in Albania has shown that there are over 300,000 cases of tuberculosis in that country, and 80 per cent. of the population are affected with the disease.[21] In Japan the average annual death-rate from consumption from 1906-1915 was 80,059, and the country is annually losing approximately £19,000,000 through the disease.[22]

In England the study of the chart (Fig. 10) showing the decline in phthisis mortality brings out two points: (*a*) The prevalence of tuberculosis is mainly influenced by large economic, social, industrial, and political factors. We have already seen that in times of peace, when industrial prosperity and continuous employment contributed to the happiness and well-being of the people, there was diminished mortality, whereas periods of war, depression in trade, economic stress and anxiety, were followed by unemployment, lower standard of living, high prices of food, and increased morbidity and mortality from tuberculosis. Even the sharp rise in tuberculosis mortality during 1914-1918, which is attributed to the great war and influenza, shows that there is a close relation between social and economic conditions and the death-rate of consumption.

(*b*) If the diminution in the mortality from the disease had continued steadily during the last twenty-five years and before, the mortality would have been about 600 per million in 1915, and 3 to 400 per million in 1920—*i.e.*, just about half or less than it was in 1920 (842 per million)—or twice as much as it should be. Taking Sir George

Newman's own calculation (p. 318), but dividing the period of 60 years or so into two parts instead of bulking them together as he has done, we find that while the death-rate fell by 1,028 per million from 1872-1897 (2,384 - 1,356 = 1,028), it only fell by 514, or just half (1,356 - 842 = 514), between 1897 and 1920, which means that the mortality fell twice as much during the period when no vigorous propaganda against tuberculosis was made as it did during the years when such efforts were conspicuous.

As for the prevalence of tuberculosis in Great Britain, Dr. Menzies,[23] taking as a basis for calculation the number of primary notifications in a year, and multiplying the number by five (on the broad assumption that the life of a tuberculous patient is about five years from the onset of the first definite symptoms of the disease), estimates that there are, roughly, 450,000 to 500,000 persons (of all ages and at all stages) who at any given moment are suffering from the disease. Again, the intensive search for the amount of tuberculosis among the Framingham community brought out the startling fact that there are ten active cases to each death from tuberculosis.[24] Applying this calculation to the number of deaths in England and Wales—say, in 1920, when it was 42,000—we get the figure of 420,000 as suffering from active disease. Looking from another point of view, the Framingham and National Service Board (America) estimates that 2 per cent. of the community are suffering from tuberculosis in a recognizable form, and that 1 per cent. are active cases and the other 1 per cent. are potential cases.[25] If this estimate is applied to the population of Great Britain (the present census of Great Britain is 42,767,530), we get the same result—viz., that there are about 420,000 active cases, a figure not very far from Dr. Menzies' calculation, if we include Ireland. So that it seems that the official number of notifications is far short of the number of active cases of tuberculosis in this country (see p. 211). If notification falls short of the actual number, is it unreasonable to suppose that the number of deaths registered as due to tuberculosis may not also represent the actual number of those that die of

the disease? Tuberculosis presents such wide variety of types, and is related to so many diseased conditions,* that it is possible for loopholes to occur which escape the official net of recognition. Are we quite sure that cases of so-called chronic bronchitis, with fever, expectoration, emaciation, night sweats, etc., and lung affections, such as unresolved pneumonia with continuous fever, are not tuberculous? That England should register nearly five times as many deaths from bronchitis as the United States[26] (male rate 20·9 in the United States, as against 106·1 for England and Wales, 1908-1912) lends colour to our doubt as to the accuracy in the diagnosis. Again, there are cases we have described as strumous, abortive, and incipient forms of phthisis, which are really tuberculous in nature, but without the presence of tubercle bacilli in the sputum, and which are probably not notified. Just as in India thousands of deaths from phthisis are registered under malaria and fevers of unknown origin,[27] so there are many ways by which leakages may occur which may account for the great disparity between the official number of notifications and those actually suffering from the disease. At any rate, in spite of strenuous campaign against tuberculosis during the last twenty-five years, that there should be nearly a thousand deaths a week from this disease, as Lord Curzon pointed out, and nearly half a million of active sufferers, including Ireland, at the present day in highly civilized England, does not give much cause for congratulation.

The Causes of the Present Situation.—How is it that our success has not hitherto been commensurate with the efforts put forth and the money spent towards controlling this disease? Sociology has shown that we have emphasized

* Tuberculosis is closely or remotely associated with asthma, emphysema, and bronchitis, pleurisy, pneumonia, whooping cough, influenza, anæmia, syphilis, cancer, rheumatism, malaria, typhoid, insanity, low blood-pressure from pluriglandular insufficiency, pregnancy, cardiovascular lesions, mitral stenosis, hæmorrhage, chronic gastritis, intestinal stasis, malnutrition, rickets, diabetes, skin eruptions, chronic kidney and liver disease, thyroid insufficiency, neurasthenia, adenitis, chronic pharyngitis, and tonsilitis, etc.

contagion too much, and have paid too little attention to the social conditions of the people, that tuberculosis is one of the social evils that man has allowed to accumulate from generation to generation, and that the present civilization has tended to create physical, mental, and moral inefficiency in a large mass of people. Biology goes further, and shows that such environmental defect to-day is liable to become constitutional defect to-morrow, creating in the child of bad heredity a lowered resistance to disease like tuberculosis.

Tuberculosis more a Social than Medical Problem.—Therefore, tuberculosis is not so much a medical, as it is a social, economic, and political problem. Almost all disease processes can be traced directly or indirectly to the vicious, social, industrial, and economic system that prevails at the present day. There is practically no constitutional disease in wild Nature. In our experience of twenty-two years of sanatorium life we never had in our midst a single case of measles, smallpox, diphtheria, typhoid, scarlet fever, or any other zymotic fever. Even influenza had lost its terrors in the sanatorium, and not one patient fell a victim to this malady, showing that country life is much more free from disease than town life; and that when to the fresh air life in the open country is added good nutrition, you have an ideal life where disease conditions cannot flourish. But slums, underfed children, alcoholism, pauperism, the army of the unemployed, and the destitute, are problems of the modern city and the present social system.

Tuberculosis and Civilization.—Civilization goes hand in hand with tuberculosis. Races like the Negro, the American Indians, etc., were virtually free from tuberculosis until they came into contact with white civilization. The growth of modern civilization has involved the conquest and exploitation of other countries, the opening of foreign markets, the extension of trade and commerce, and the accumulation of wealth. The industrial and commercial expansion has brought with it the multiplication of machines and mills, of factories and workshops, the decline of agriculture, the migration of rural population, and over-crowding of

towns. Menzies[28] reckons that while the urban population of England was 20 per cent. in 1810, it rose to 80 per cent. in 1910, and would very likely be nearly 85 per cent. at the present day. This enormous overcrowding of cities and manufacturing centres is followed by keen competition, economic stress, seasonal trade, casual labour, irregular work, unemployment, poverty, and want. So that civilization has tended to create two opposite evils—wealth and poverty, and both cause physical and moral inefficiency. Since poverty is the lot of the many, the greater proportion of social inefficiency falls upon the poor classes.

Tuberculosis is a Social Evil.—Tuberculosis is a social evil, and is connected directly or indirectly with almost all other social evils of modern civilization. Fresh air, good food, and decent accommodation are the basic needs of every human being. Deprive him of these elementary wants, you set in motion many physical, social, and moral ills, which add impetus in every generation, like the stone that gathers momentum as it falls. All the social evils gather round unemployment and poverty, which lead sooner or later to overcrowding, slums, drink, sickness, disability, mental and moral weakness, pauperism, crime, and insanity; and tuberculosis comes as the cause and the effect of this vicious circle. Let us proceed to study briefly this question.

Tuberculosis and Poverty.—To begin with, of all the predisposing causes of consumption among the poor, poverty comes first and foremost. It is reckoned that about 70 per cent. of consumption occurs among the poor. By the poor we do not mean the working-classes only; we include all those whose income is not sufficient to provide them and their families with those bare necessaries of life which are essential for the maintenance of physical efficiency and health. This includes many classes and conditions of workers—from the homeless vagrant and the casual labourer to the humble clerk, the impecunious curate, the draper's assistant, and the shop-girl, whose poverty is no less terrible because it is hidden under respectable appearance, and whose margin of subsistence is so narrow that any economic

disturbance or ill-health would bring them to the verge of distress and destitution.

Charles Booth found that 30·7 of the London population were on or below the poverty line. It is not our province to enter into the many causes of poverty. It is certain that more poverty is caused by misfortune, such as lack of employment, insufficient earnings, sickness, old age, physical defect, than by misconduct, such as improvidence, laziness, vice, and crime. Whatever be the social, economic, and industrial causes, it leads to underfeeding, distress and anxiety, sickness, reduced working power, and still greater poverty.

In the next stage poverty leads to overcrowding and slums. The family which occupied three or four rooms seeks smaller accommodation, and, as destitution increases, removes to a one-roomed tenement, and gradually drifts into slums or workhouse. From the census returns of 1911 it was found that over 800,000 people in Great Britain were living in one-roomed tenements. In London there were 300,000 one-room dwellers, of whom 3,000 were living eight in a room, over 9,000 living seven in a room, and at least 26,000 living six in a room;[29] and since the war the house famine has made matters worse. It was shown that about half the whole population of Scotland live in houses of from one to two rooms. 'I myself know of houses,' declared Mr. John Robertson,[30] 'that were condemned as unfit for habitation during the cholera epidemic of 1840, yet they are inhabited to-day and are more overcrowded than they were in 1840.' The awful slums—lodging-houses and one-roomed tenements of London, one or two of which we have visited—who can describe their dismal surroundings, their dark stairways, the dingy passages, the dilapidated walls, the air rank with dirt and damp, the rooms grim and bare and squalid, where thousands of fallen humanity of all ranks seek shelter for the night or live day by day, miserable, monotonous lives, where the ragged child, the sickly poor, sleep huddled together or stretched on the bare floor. Here poverty and want hold high revel, tuberculosis and immorality find a seed-bed, and

crime and insanity supply material for future generations. No wonder Dr. Addison[31] said that 'slums are one of the most costly and dangerous of our social evils.'

In the still further stage, poverty becomes hopelessly mixed up with overcrowding, slums, drink, sickness, and vice. It is impossible to separate the cause and effect of drink, which often goes with defective sanitation, bad housing, and low standard of living. True, alcohol is a terrible curse. It tends to poison the germ cells, retard tissue formation, injure the vascular and nervous systems, hinder digestion, and hands down its evil inheritance to succeeding generations. But poverty is often the parent of drink by directly provoking it in some instances, and in others by weakening the will so that the victim falls an easy prey to its temptations. When all these social evils combine their forces, the physical and moral degeneration becomes profound.

Mental and Moral Results.—A life of prolonged want and destitution lived in overcrowded and insanitary surroundings produces lowered resistance, backwardness among children, and feebleness of mind. Poverty starves the brain, dulls the intellect, takes away self-respect and a spirit of independence. The brain gives way under the constant dread of hunger and anxiety. The unemployed becomes in time unemployable, as, when he loses all heart and ambition in life, he loses interest in himself and others, and power and ability to work. Mean streets, congested areas, and drab surroundings, depress the mind. It is so hard to be good and moral in a vicious and cheerless atmosphere. When children are reared in miserable homes and amid squalid ugliness, they lose all taste and refinement and become coarse and sensual. In one-roomed family life virtue cannot flourish, nor is decency possible. So chronic want and sordid home life and surroundings lead to moral degeneration, feebleness of intellect, to crime and insanity, as seen by the fact that the majority of the poor and the submerged fill the workhouse, the asylum, and the prison.

The Second Generation.—The unfortunate child that is born of poverty inherits the weakness of its parents, and

begins its life very much handicapped. Add to this the fact that a large majority of them cannot get natural food from their mothers, who either have no milk with which to feed them, or their work in mills and factories gives them no opportunity to nurse the little ones. Hence, in wealthy Bradford, where practically all mothers go out to work, and breast feeding is a curiosity, the infant mortality[32] is 132 in 1919, while in poor County Roscommon, Ireland, where the children are breast-fed, it is only (1916) 35. When the children do survive these bad conditions, their bodies are stunted, their teeth decayed, their digestion weakened, the bones rickety, their whole constitution starved, and they become a prey to scrofula, tuberculosis, etc. No wonder many of the young people bred in poor and ugly surroundings, brought up by wrong feeding, bereft of sound education and moral training, deprived of home life and influence, have not the stamina or the strength to face life's stern duties and problems, and drift away by strong under-currents, and sink to a lower and lower abyss, giving birth, in their turn, to children as physically and mentally defective as themselves, to swell the ranks of inebriates and criminals. The want of fresh air and food in the early years of childhood is seen in the decline of vigour and vitality of young men and women. One has but to look at the pale, tired faces, stooped shoulders, and flat chests of the mill, factory, and shop-girls in the big manufacturing centres and towns to notice the degenerating effects of the modern industrial system. No wonder that literally thousands upon thousands of recruits in London and all the important cities and towns in England and America were rejected as unfit during the great war.

Tuberculosis, Poverty, and Other Social Evils.—Tuberculosis and poverty are closely connected with many other social ills. Vile air and vile surroundings cannot produce bright eyes, cheerful faces, sound bodies, or sound minds. Dr. Goring[33] found that physical and mental infirmity were allied to a low economic scale of living, and that crime was associated with defective stature and defective mind. The

Chief Constable[34] of Exeter says that 'poverty is one of the great causes of juvenile delinquency, as, in his opinion, it undoubtedly is of crime.' The Prison Commissioners, in their report in 1918, say that decrease of crime by nearly 80 per cent. was due to the late war affording endless opportunities for service and employment to those who otherwise would have drifted into crime and prison. In Italy 87·9 per cent. of criminals came from families with profound poverty.[35] Two-thirds of cases of delinquency among Chicago children were from badly-housed districts.[36] Criminologists like W. D. Morrison[37] state that density of population is one of the main causes of crime. So crime, like tuberculosis, is mostly a social and economic question. That one-fifth of all deaths amongst prisoners is due to some form of tuberculosis, as Goring[38] found, shows another link between tuberculosis and crime.

So also syphilis can be considered as chiefly brought about by social and economic causes. Insufficient wages of women tend to contribute to a low standard of morality, as they are tempted to supplement their poor earnings by immoral means.[39] The inadequate salaries paid to thousands of young men employed in shops, warehouses, and factories, etc., prevent them from marrying and providing a home; hence one cannot be surprised when sexual lapses result in venereal disease. Again, poverty and insanitary surroundings, especially when there is a constitutional defect, weaken the will and resisting power, so that men and women fall an easy prey to immorality and crime.

So also mental unsoundness, imbecility, and insanity can be traced in many cases among the poor to an hereditary defect born of economic causes in the first instance. Foul air and poor food stunt both the growth and the intelligence of the child. Taking England as a whole, the children of the working-classes are several inches shorter and several pounds lighter than the children of the more well-to-do. There is a close connection between insanity and overcrowding. The Mayor of Poplar found, after careful analysis, that whereas the increase of pauper lunacy for all London

was 1·9 per cent., in the overcrowded districts it was 10·1 per cent.[40] That tuberculosis and insanity are the outcome of lowered resistance is seen by the fact that both often go together. It is well known that tuberculosis is rife among idiots and lunatics.

So that we can conclude that almost all the social and moral evils that plague civilized mankind are associated, directly or indirectly, with tuberculosis, and are caused by vicious, social, and economic conditions that prevail among civilized people. Now, the question arises: Is tuberculosis determined by poverty or poverty by tuberculosis? We should say that poverty, in the first place, leads to tuberculosis through lowered vitality, and then it becomes the effect of tuberculosis from ill-health and disability for work. There is still a wider question: Is a consumptive a defective because he is tuberculous, or tuberculous because he is a defective? Is a workman unemployed because he is unemployable, or *vice versa?* Is inefficiency the cause or the effect of social evils? One school holds that tuberculosis and other social evils are caused by defective environment, and another school holds that they are caused by defective endowment. We have already pointed out that environment to-day may become endowment to-morrow, and that both with personality can influence and shape men's lives for good or ill. But this does not mean that man is inherently sinful or criminal, or inherently tuberculous. Man is no more born criminal than a consumptive is born with tubercle bacilli. True, good nurture may not eradicate the effects of bad heredity in a single generation, but this is not to say that a persistent favourable environment with strong personality cannot wash off the stains of bad heredity in course of time. We can go further and say that some of the vilest and most degraded characters and habitual criminals have, when brought under intense spiritual influence, been quickly transformed into sober and good citizens, apparently in defiance of recognized laws of heredity and biology.[41]

Tuberculosis among the Middle and Upper Classes.—If about 70 per cent. of tuberculosis can be accounted for

among the poor, what about the rest? There is much poverty among the middle classes, many of whom suffer in silence from the effects of fixed incomes which are often barely sufficient to keep their families in ordinary comfort, and from the heavy burden of taxation. To keep up appearances and to obtain the comforts of life they work all the harder, suffer from keener competition and spend more nervous energy than either of the other two classes. Hence exhausted by overwork, their struggle for existence is just as severe, if not more so, than that of the poor, and so many fall under the mental strain and fatigue, which prepare the soil for tuberculosis and other maladies.

As for the rich, tuberculosis is not only caused by insufficiency of air and food, but also by inefficiency of gastric organs to bring about healthy assimilation and nutrition. A life of luxury and overindulgence exhausts the energy of the nervous and digestive systems, leading to abnormal bacterial decomposition in the intestines, and destruction and waste of food materials. So that malnutrition and ill-health can result from overfeeding as well as from underfeeding. Added to this mental work, worry and responsibility on the part of the well-to-do cause a great deal of wear and tear of life, undermine the nervous system, and bring fatigue, toxic products, disease processes, and tuberculosis. So in both the rich and the poor we can trace the relationship between tuberculosis and many of the social conditions fostered by modern civilization which has burdened a larger class with the effects of poverty and the smaller with those of wealth, and both with stress, anxiety, tuberculosis, and inefficiency. All the social evils can be summed up in one word—insufficiency or defectiveness. The poor suffer most from defective nutrition, defective physical, mental, and moral surroundings. And when the mischief is done, and the degeneration is more or less complete, we intervene too late in our rescue work. How foolish it all seems that after creating conditions which make criminals, paupers, lunatics, and consumptives, the nation proceeds to organize an elaborate machinery, provide an army of officials, and spend

millions of money to build prisons, workhouses, asylums, and sanatoria, to incarcerate the wrecks of humanity, which are but the products of the social system which it had allowed to continue for generations. Ruskin once said that when a murder was committed in London he would place all its citizens in the dock.

It is one of the terrible ironies of the present day that, while England is constantly extending her conquests in circumference, in the very centre of the Empire her own sons and daughters find no room to live, and go about the streets in want of the barest sustenance that is not denied to the savage and the Hottentot; that while she is spending her energy in conquering and killing her foes hundreds of miles away, she has allowed the enemy at her very door to destroy thousands of her children in the prime of their lives. Mr. Rowntree, in his book, declared that there were no less than 13,000,000 of the inhabitants of the United Kingdom on the 'hunger line.' Sir James Crichton-Browne said that there was reason to believe that 30 per cent. of the population were still living in poverty, ill-clothed and underfed, and in insanitary conditions conducive to mental deterioration. England's real foes are not outside, but are within her own borders—foes that are sapping the life-blood, and causing the physical and moral wreck of her citizens.

Conclusion.—Thus the social evils of civilization are mostly economic evils, and both underlie all disease processes including tuberculosis. Whatever undermines the vigour of the body makes disease possible. The undue prominence given to the microbe factor has obscured the real significance of social and nutritive factors of tuberculosis which are the outcome of the modern conditions of civilization. It is not poverty alone, but social evils that cluster round it, that intensify its effects and make for tuberculosis and other social disease. The present social and economic conditions do not favour the full growth and development of many an individual. The purpose of evolution is to lead man from a primitive life to gradual stages of progress and civilization. The very falls and mistakes of a nation are part of the

evolutionary scheme, and can be made the stepping-stones to the realization of larger sympathy and service, and to an endeavour to secure a larger life and health to fallen humanity—humanity which is crushed by the grievous burdens which social and economic wrongs have imposed on it.

REFERENCES.

[1] State Action in the Prevention of Tuberculosis, by Sir George Newman.

[2] Perrin, *Paris Médical*, February 28, 1920.

[3] John Burns at the Tuberculosis Exhibition, London, June, 1909.

[4] 'Tuberculosis and Race Stock,' *Statis. Bull. Metrop. Life Insurance Co.*, May, 1920, vol. i., No. 5, 4.

[5] Modern Medicine, November, 1920, p. 715.

[6] 'The Tuberculosis Death-Rate,' Editorial, *New York Med. Journ.*, October 11, 1919.

[7] The Spectator Life Insurance Section, September 23 and 30, 1920.

[8] *Modern Medicine*, February, 1920, p. 133.

[9] 'The French Death-Rate,' *Le Matin*, May 22, 1913.

[10] 'French Tuberculosis Work after the War,' by Bernard, *Clinical Medicine*, April, 1920, vol. xxvii., p. 229.

[11] Kirchner, *Tubercle*, September, 1921, p. 567.

[12] *Tubercle*, November, 1919, p. 82.

[13] 'Economic Condition of the Poorer Population of the City of Trier,' by Bruns, *Military Surgery*, April, 1920.

[14] Same as reference [11].

[15] Editorial, *Boston Med. and Surg. Journ.*, July 22, 1920, vol. clxxxiii., p. 114.

[16] *Tubercle*, November, 1920, p. 83.

[17] Same as references [11] and [14].

[18] The Health of the Nations (International Council of Women), p. 114. Constable and Co., London, 1910.

[19] Stouman, *Amer. Rev. of Tuberculosis*, vol. iv., 1920-21; abstracts, p. 178.

[20] Same as reference [18], p. 182.

[21] 'News of the Week,' *Medical Record*, June 19, 1920.

[22] 'Yeiseikai-Zasshi,' 1919, **37**, 135; *Tubercle*, July, 1920, p. 468.

[23] Menzies, Report of the London County Medical Officer of Health and School Medical Officer for 1919.

[24] Same as reference [8].

[25] *Ibid.*, *Tubercle*, August, 1921, p. 516.

[26] Same as reference [7].

[27] Muthu, 'Tuberculosis in India,' *The Practitioner*, March, 1918, p. 278.

[28] Same as reference [23].

[29] Social Problems and the Church's Duty, p. 32. A. and C. Black, London, 1912.

[30] Robertson, Debate in the House of Commons, July 28, 1921.

[31] Dr. Addison, 'What Slums cost in Terms of Cash,' in *Manchester Guardian*, July 30, 1921.

[32] 'The Factors of Infant Mortality,' by Saleeby, *The Theosophist*, April, 1920, p. 33.

[33] The English Convict, by Charles Goring.

[34] *Humane Review*, January, 1919, p. 249.

[35] Criminality and Economic Conditions, by Bangor, p. 486.

[36] *Modern Medicine*, July, 1919, p. 227.

[37] Same as reference [29], p. 18.

[38] Goring, same as reference [33].

[39] Same as reference [18], p. 120.

[40] Same as reference [29], p. 38.

[41] 'Broken Earthenware,' by Harold Begbie, p. 98.

CHAPTER XXIII

THE PREVENTION OF TUBERCULOSIS

'It may be broadly stated that an advance in material prosperity of the community as a whole will be reflected in a decreased incidence of tuberculosis.'—*Report of British Departmental Committee on Tuberculosis.*

'That country is richest which nourishes the greatest number of noble and happy beings.'—RUSKIN.

'The happiness of a great people was the sole object of government.'—GIBBON.

WE have thus far attempted to show that tuberculosis is a product of defective nutrition and defective environment, that it is more a biological and sociological than a bacteriological and pathological question, and that it is inextricably bound up with other social evils which, working in a vicious circle, intensify the effect of each other to the physical and moral detriment of the nation. The success of the open-air treatment is both the acid test and acid proof of our contention. For it is because poor nutrition and bad environment are the cause of tuberculosis, that improved well-being and good environment do cure and arrest the disease in a large number of cases. When once this truth is brought home to the heart of the nation, it can be trusted to devise measures of treatment and prevention which can be adapted to the varying needs and conditions of the people from time to time. Here, in this chapter, we shall only consider very briefly general principles that would be a rough guide in carrying out such preventive measures. Going to the very root of the matter, we can lay down as first principles the following:

First Principles.

1. That health and efficiency are the greatest asset of every worker, and sickness and disability his greatest calamity, as they mean poverty, illness, financial distress and misery.

2. That fresh air, nourishing food, and decent accommodation ensure a great measure of physical health and efficiency, happiness and contentment.

3. That a nation which produces the greatest number of healthy and happy citizens is the most civilized, most prosperous, and best equipped to hold its own amidst the stress and competition of the world.

4. It is therefore the duty of every civilized State to see that its workers are placed in the way of being provided with these elementary wants that make for national health and security.

These broad principles are coming to be recognized as fundamental truths that should guide every civilized country in the government of its people. With reference to tuberculosis, we next go on to affirm that:

Second Set of Principles.

1. Tuberculosis is chiefly associated with poverty, overcrowding, slums, and other social evils.

2. By working to get rid of tuberculosis we are working to get rid of many social evils that have brought misery and unhappiness to civilized people.

3. Tuberculosis and other social evils, when traced to their source, seem to be bound up with big industrial and economic issues, such as unemployment, the distribution of wealth, fair wages, the regulation of hours of labour, the land question, housing, etc.

4. So almost every medical question becomes ultimately a social and economic question, requiring to be dealt with by the community as a whole, by social reformers, and the sanitary, the municipal, and political authorities.

Such a social and economic aspect of tuberculosis puts aside the microbe factor, and points out that a man's working capacity and economic value depend upon his wellbeing, and lays stress on his environment—his food and drink, his occupation, wages, housing accommodation, his home surroundings, etc. The fundamental basis of all health is nutrition, and all social and economic conditions that interfere with

nutrition lead to loss of resistance and make disease possible. So medical questions cannot be separated from social problems. Tuberculosis is inextricably associated with the general living and working conditions of the people, and is therefore a sociological problem which, in the next step, involves labour and political issues—a step which the medical profession may not be willing to take; but if it is in right earnest about the prevention of tuberculosis, it is bound to go further and enter into the economic and political aspect of the disease, and make its voice heard in settling the labour and social problems of the day, such as unemployment, low wages, bad housing, slums, child welfare, etc.

If by some miracle unemployment and destitution are abolished from the land, every man has work to do, a fair and living wage, good and sanitary accommodation and wholesome surroundings, there is no doubt that tuberculosis will be eradicated in a few years. The mothers, being freed from poverty and anxiety, will be able to stop at home and nurse and look after their children, so that infant mortality and child tuberculosis will be very much diminished; more young men will earn sufficient to enable them to marry, so that syphilis will not be a formidable plague as it now is; and crime will be diminished to the smallest proportion, as it was during the war. But social and economic evils have been allowed to accumulate from year to year, from generation to generation, so that they have now become more and more difficult to solve, and are the despair of the reformer and the politician, who find they have not sufficient courage and strength to strike at the root of these evils. Hence they have resorted to palliatives and doles that have not touched the main disease, which, like a running sore, remains undermining the physical and moral health of the people.

What is being done.—The general measures undertaken by the State, the municipal and other authorities, to meet poverty, unemployment, destitution and sickness, are chiefly: The administration of poor law relief, the unemployment benefit, the insurance benefit, maternity benefit, medical supervision of school children, free meals for necessitous

children, the provision of creches and day nurseries, dental and other clinics, besides the help given by voluntary social workers, church agencies, health visitors, and by private benevolent enterprise.

Among the benefit schemes in respect of tuberculosis that have been put into operation or in contemplation may be mentioned: The provision of tuberculosis dispensaries, medical supervision by tuberculosis officers, nurses and staff, the sanatorium and hospital accommodation, domiciliary treatment, after-care supervision and work arranged by tuberculosis after-care committees, training centres and workshops, industrial colonies, village settlements, open-air day and residential schools, sanatoria for children, etc.

Palliative and Preventive Treatment.—All these benefits may be good in their way, and may be necessary as a temporary measure, but many of them do not aim in eradicating social evils. Unemployment and slums cannot be radically dealt with by such palliatives. Merely giving relief to people after they have become paupers and derelicts is like sprinkling some carbolic powder over a broken sewage pipe; the disinfectant only disguises the real danger of poisoning by sewer-gas. The workhouse system, as the writer pointed out many years ago, is both demoralizing and inhuman, and ought to be abolished, and some scheme of out-door relief planned on a generous scale should be substituted, which does not destroy the independence of or break-up the family that seeks assistance. But all doles are demoralizing. They are no solution of prevention of a social disease like tuberculosis.

Some of the above-mentioned measures undoubtedly aim at prevention. In the complete tuberculosis scheme put forward by the State and local authorities, the dispensary, the sanatorium, the after-care and colonies take a prominent part. The dispensary would be doing a good work if its main aim is to find out early cases with a view to early treatment. The educational value of a sanatorium among a wide circle of patients' relatives and acquaintances lays a sure foundation for the prevention of tuberculosis in the future. The

sanatorium benefit in the Insurance Act has not proved a success in the past; it could be improved if the stay in the sanatorium is extended as long as it is necessary. The sanatorium could be made useful in many ways by extending its activities, as we shall presently see. The proposed scheme of colonies and village settlements on an extended scale for ex-patients should be approached with caution, as it bristles with difficulties and drawbacks. The object of the colony is to provide facilities for the patient to carry on his old occupation or learn some new trade under ideal conditions and skilled supervision. But if it is going to be worked like a leper colony, where consumptive patients are practically deported and segregated, it should be condemned. No colony, in our estimation, should be run on the principle that the tuberculous are infectious people, and ought to be segregated like lepers in the interest of the public, and that it should be 'run by consumptives for consumptives.' It is wrong scientifically, ethically, humanely, and psychologically. The tragedy of many tuberculous schemes is that men with immature minds and narrow outlook should be given power to inflict misery and pain to thousands of silent sufferers by their ill-conceived schemes and measures based on infection in home life. As we have already pointed out, it is not so much the home environment as nutrition that is at fault in many a working-class family. In Birmingham it has been shown that while the mortality rate for males between thirty-five and forty-five was 4·5 per 1,000, it was only 1·6 for females, though they spend more time in the house than do the men, which emphasizes that it is not the infection factor so much as the food factor that would influence the relapse of ex-patients when they return home. The authors of *Industrial Colonies for the Consumptive* have made a mistake when they consider that the State subsidy without segregation would be futile. The segregation of tuberculous patients should not be made a condition for any State help that may be given them. Man is a social being, and his living relation with the outside world is part of his healthy environment. The patient's desire for home

life should be satisfied, and this satisfaction and contentment will go a long way to complete the arrest of his disease. So with children. By segregating them in an open-air institution for many months they are deprived of home life and home influence so necessary for the building-up of their morals and character. All attempts to secure physical health at the expense of mental and moral well-being will only end in greater disaster. The psychology of the consumptive demands that the integrity of his family should be preserved in all after-care schemes promoted by the State or private enterprise.

Village Settlements.—For this reason better than colonies are village settlements, where convalescent patients can go and live with their families in healthy homes amidst healthy surroundings. We go further and say that all settlements, like garden cities, should be open for all, and not restricted to tuberculous patients alone, so that they may consider themselves as one of the great human family, and mixing with others they may throw off any suggestion and fear of the disease haunting their minds.

Even village settlements will not be an advantage to ex-patients if they are situated far away from their home surroundings and from their place of business. Besides, all these colony and settlement schemes involve an enormous outlay, which may be out of all proportion to the advantage gained in settling a few families. Again, we find that in practice it is not easy for a patient to change his old occupation, in which he is skilled and which he has devoted many years to master. Farming conditions are hard and unsuitable to many sanatorium patients. The so-called light farming or light work in the country so thoughtlessly advocated does not exist. The real problem concerning a tuberculous patient is how to get him quickly well, how to get him into some work where he may earn a living wage without suffering a relapse, and how to avoid a large expenditure and big schemes, which may be both complicated and unworkable. Towards the satisfactory solution of these problems we would submit the following :

Third Set of Principles.—(1) All tuberculosis schemes should be devised with the view that they are not going to be permanent, and that tuberculosis is not going to be with us always. (2) The diagnosis and treatment of early cases is absolutely essential in the interest of economy and of all concerned. (3) The scope of the existing sanatoria should be extended where necessary to embrace many activities. (4) The home environment of the patient should be improved so that he may carry out the treatment begun in a sanatoria.

1. The nation should be careful not to commit itself to any large tuberculosis schemes, because for one thing we hope that tuberculosis, like leprosy, will one day be eradicated if we strenuously persevere in improving man's environment. The isolation hospitals are not in such a demand now as they once were, and will be less and less needed as zymotic fevers are more and more brought under control. And so it will be with regard to tuberculosis. Any permanent schemes involving a big financial outlay may become as obsolete in a few years as isolation hospitals are at the present day, unless they form a part of improved housing movements, such as Bournville, Port Sunlight, Earswick, Letchworth, and other garden cities.

2. The whole secret of solving the tuberculosis problem lies in detecting and treating pulmonary tuberculosis in its very early stage. By such a course we would save chronic invalidism of the patient, domiciliary treatment, after-care and a host of financial, sanitary, and social measures which would became necessary if the disease is left to progress. Every means should be taken to bring early cases to light so that convalescence may be established after a few weeks' stay in a sanatorium, and the patient be enabled to resume his old occupation. The earlier the treatment the shorter the stay in a sanatorium, the larger the number of restored patients with working capacity and the greater the reward of the country in reclaiming many lives for active usefulness. On the other hand, the longer the diagnosis and treatment is delayed the greater will be the number of incurables, and

the more severe the misery and burden both to the family and the nation. Therefore, the physician should not wait to find the evidence of tubercle bacilli in the sputum before he decides to send the patient to an open-air institution. There are enough early signs and symptoms (see Chapter XIII.) from which a positive diagnosis can be made without the presence of tubercle bacilli. We can go further, and say it is worth while to send a patient to a sanatorium even only on suspicion as a means of prevention, so that the patient may have the benefit of the doubt, and be recuperated in mind and body by a short stay in the country under ideal conditions and medical supervision. The so-called non-tuberculous cases, said to be treated in a sanatorium, are really suspicious cases sent to prevent further complication, and which would be all the better for their stay in an institution. So many interests are involved in the early detection and treatment that we would strongly urge the profession to concentrate its energy in ferreting out early cases for advice and treatment. The secret of the success of the Framingham community lies in their enthusiasm and intensive search for the disease. At first the search would discover many advanced cases as in Framingham[2] (where 55 per cent. of cases were discovered in the advanced stage, and later this was reduced to 17 per cent., while the death-rate was reduced from 121·5 to 64·5 per 100,000), but as it progresses more early cases will be brought to light for treatment. Any scheme or machinery by which the patient can be found out early and saved before he gets into a chronic and incurable stage ought to be welcomed. If the dispensary system, notification, and sanatorium, can provide such a machinery, their existence will be justified.

3. The existing sanatoria could be made centres of many beneficent activities. (*a*) They should devote their time to treating early cases, so that the patient may return home as quickly as possible and resume his old work. (*b*) They could go further, and treat patients in the pre-tuberculous stage, with a view to prevention. For this reason the Grancher system of planting children threatened with

tuberculosis, not in institutions, but in country homes, has much to commend itself to this country. Its success is not due to the removing of the children from tuberculous contacts as its advocates allege. It undertakes to treat them in the scrofulous or suspicious stage before poverty, malnutrition, or vicious environment has time to develop the disease. It helps to build up their little bodies with resistance by fresh air, good food, and country life. Lastly, it provides them with home life and family surroundings while under treatment. If we are to make any headway in the control of tuberculosis, and obtain the greatest possible return for the money spent, the sanatorium should become more and more a preventive institution rather than that it should fill its beds with more or less advanced cases with little prospect of cure. (*c*) Their scope can be extended by fitting them up with workshops at which suitable trades or some open-air occupation, such as gardening, poultry farming, etc., can be taught to patients, so that while under medical supervision, they may be learning some manual work, thus doing the work of colonies—at least in a preliminary way—without incurring any additional outlay necessary for the establishment of a colony. (*d*) They can follow up cases and keep in touch with old patients and examine them periodically, and in this way the sanatorium physician can be of great help in the follow-up system and after-care of ex-patients.

4. Improving the home conditions of the convalescent patients will be an easier solution when compared to the vast expenditure involved in establishing industrial, farm, and residential colonies and settlements. The principle is that instead of taking the patients away to live in ideal surroundings, to bring ideal conditions to their own homes. When every city is a garden city, and every home a sanatorium, the patient need not go away to seek healthy conditions elsewhere. Till then the problem of the treatment of tuberculosis will be much simplified if we devote our energies to early treatment of the patient with a view to his early resumption of work, and to improve the environment both at home and in his place of employment.

What is to be done in the Way of Prevention?—But even colonies, village settlements, sanatoria, and early treatment deal only with existing cases. They cannot prevent the incidence of tuberculosis. We may give doles, dental clinics, or domiciliary treatment till the end of time, and yet not eradicate the disease. The problem of every civilized State is how to maintain the health and happiness of its people without demoralizing them. As long as such questions as unemployment, poverty, insufficient wages, insanitary housing, overcrowding and slums are left as they are, there is no hope of dealing with the prevention of the disease. It is like trying to pump out water from a ship that has sprung a bad leak. As fast or faster than you can pump, the water rushes in through the hole and fills the ship. As fast as you cure patients, their places are filled by others manufactured by the existing conditions. So we come back to the old story—*viz.*, economic and social conditions are the bed-rock of tuberculosis and other evils. So we go further and lay down the necessity of:

Fourth Set of Principles.—(1) Better understanding between capital and labour. (2) Better distribution of the necessities of life. (3) Healthier and happier conditions of labour. (4) Better housing.

To carry out these reforms a new mentality, a new spirit, a reorganization of the whole economic and industrial system would be necessary—an altruism which would bring about a better understanding between capital and labour and ideas of co-operation and brotherhood in commerce and industry instead of antagonism and competition. But it may be rightly pointed out that even the united efforts of capital and labour cannot achieve much at present as, owing to post-war conditions and international complications, there is a state of unrest, depression of trade, decrease in manufacture and exports, an uncertainty of exchange, and consequent unemployment and distress. It is quite true that social and economic problems have become the concern of the State and ultimately an international affair, and that the fluctuation of exchanges, unemployment, and industrial

dislocation are only symptoms of the world's disease and not the disease itself. The prosperity and adversity of one nation affect equally other nations. You cannot hurt your neighbour without hurting yourself. War has brought chaos, confusion, stagnant markets, and economic distress, while peace and goodwill and co-operation among nations alone can restore stability, revival of trade, and industrial development. So we go further still to the root of all reforms when we say:

Final Principles.—(1) Stop all wars and war expenditure, reduce armaments, and promote peace. (2) Reduce the burden of taxation, free the imports and exports, cheapen the necessaries of life. (3) Encourage industry, promote agriculture and small holdings so that the people may grow and live on fresh food, carry out land reform and land development. (4) Help to multiply garden cities and garden suburbs, clear slums and build houses.

1. A comprehensive programme, but there are no means available at present to launch out any such big schemes may be the reply. But the country spent millions upon millions of money in destroying lives far away, surely it can spare a tithe of it in saving the lives of its own children.* War is a

* The figures below show the great post-war increase of expenditure on armies and navies in the Allied countries :[3]

	1913-14 (approximately).	1920-21 (approximately).
United States	£63,000,000	£182,000,000
Britain	£28,416,000	£164,750,000
France	£37,000,000	1920. Fcs. 4,952,000,000 (£198,000,000) 1921. Fcs. 6,546,000,000
Japan	£10,000,000	£23,000,000

On the other hand, many years of life are lost to every individual and to the nation because of tuberculosis. Life tables show that the eradication of tuberculosis carries with it a saving to the average human life of from two and a half to three and a half years, with a corresponding increase in the health of the country amounting to billions of dollars (millions of pounds[4]). Latham and Garland have calculated that 40,000 deaths

prolific source of poverty, and causes increase of taxation, high cost of living, unemployment, crime, misery, and distress, besides leading to many a disease like tuberculosis. Who can doubt that the present economic crisis is the direct consequence of impoverishment of Europe due to five years of war? Did not President Harding[6] say that 'the enormous disbursements in rivalries of armament manifestly constitute a greater part of encumbrance upon enterprise and national prosperity?' Universal disarmament is the only sure guarantee of international peace, revival of trade and industry, prosperity and health.

2. The burden of increased taxation is pressing heavily upon all classes, especially upon the middle and lower classes. The increased cost of living means less food and less staying power, and more malnutrition, rickets, and tuberculosis. Any State legislation that cheapens food increases nutrition. Sir Douglas Powell[7] was quite right when he found that the abolition of the Corn Duties and other Free Trade legislation had done a great deal towards the prevention of consumption. Sir Hugh Beevor[8] says: 'As the wages rise, phthisis rate falls. This fall affects especially the young; it is due to food supply.' Even Germans like Dr. Kurella[9] had to acknowledge that consumption has declined in this country since the abolition of the Corn Laws, and that insufficient food is one of the main causes of its spread among the German working-classes. Dr. Kurella gives the following interesting figures:

	England and Wales.	Prussia.
	Per 100,000.	Per 100,000.
Average deaths from consumption in 1887-93	156·8	247·7
" " " " in 1894-97	135·8	224·5

Dr. Baskett[10] points out that during the Caprivi treaties, which were the German Empire's nearest approach to Free

from consumption and 20,000 from other forms of tuberculosis represent a loss of £26,000,000 annually in England and Wales, and £66,000,000 in the United States.[5]

Trade, the rates of mortality from phthisis fell as never before, while the Bülow tariff first checked, and then lowered, the rate of fall. So Dr. Baskett has come to recognize a remarkable relation between a high tariff and a high tuberculous rate. Sir Alfred Mond[11] has drawn attention to the significant fact that the death-rate is lowest in Free Trade countries—England, Denmark, and Holland—and highest in the most highly protected countries, and that in former countries the bulk of the population are better fed, better clothed, and better housed than in protected countries. There is no doubt there is a causal relation between taxation, high cost of living, and decline in the standard of living, and increase of death-rate and tuberculosis.

3. Of all the preventive measures that would bring salvation and health to this country, the most important, the most permanent and satisfactory, and the most pressing, are those which would keep the people in the country, and give them a direct interest in the land. It is reckoned that about 85 per cent. of the population of England have migrated into towns. The steady decline of the rural population is a growing menace which this country must take serious steps to put right. The depopulation of the country is chiefly owing to lack of housing accommodation, difficuly in getting land, lack of scope for the energies of country youths, and lack of educational advantages. The open-air treatment has taught this important lesson: that, while conditions of town life are enervating and demoralizing, the country life tends to make for health and to ward off disease. Here lies the secret of national efficiency, the solution, to a great extent, of the social problems of poverty, overcrowding, and unemployment. It is not by building more *Dreadnoughts*, but by building up more the vigour of manhood and womanhood, that England would meet the increasing demands made upon her by industrial stress and international competition. Hence she must take all possible steps to stem the tide and divert the flow from town to country.

Emigration is draining England of some of her best sons. It is absurd to send away strong men and women to other

countries to find work when there are here millions of acres of land lying idle and waiting for cultivation. According to Mr. Rider Haggard, 'two-thirds of the productiveness of the soil is run to waste; the desertion of the country is destroying the last remnant of our old village life, and is increasing by a sort of compound interest the monotony and loneliness of a country existence.' Mere agricultural or technical training will not avail unless it is undertaken with the definite object of settling the people in small holdings, with a fixity of tenure, or in some other way giving them a permanent interest in the land. In 1914 this country imported apples, potatoes, poultry and game, eggs, butter and cheese, to the value of forty-seven millions. At least part of this profit would have remained in the hands of English people by more extensive and intensive cultivation and by the revival of dairy, fruit, and other agricultural industries. England has plenty of land and plenty of markets for her goods. Her home market alone is large enough to take all her produce.

Fifty years ago, as Lansbury says, Denmark was the poorest country in Europe. To-day she is one of the most prosperous. Her people are neither very poor nor very rich. Her soil is inferior to some of the worst in this country. She exports to us millions of pounds' worth of dairy produce, bacon, eggs, etc., and is able to do so because her people are taught from youth up the value of training and efficiency and co-operation.

We can learn from them and improve. We can create a new market here in our midst, and by so doing hasten the day when we shall be independent of the outside markets of the world for our food supply.

So the land question seems to be the supreme and most vital of all social questions, and unless it is satisfactorily settled in the interests of the people, the town population will swallow up the country, and the disappearance of the peasantry will be followed by degeneration of the race.

4. In the housing scheme the planning of open-air schools, open-air factories, and garden cities in the suburbs of great

towns will not only help to improve the health and the enjoyment of the people, but will also go far to solve some of the problems of the after-care of ex-sanatorium patients and the prevention of tuberculosis.

It has been shown by the open-air, the garden city, and other movements, that fresh air and sunlight, beautiful and healthy surroundings, are essential for the sound development of body and mind, and for the growth of child-life.* The housing condition of industrial towns and mining centres is truly deplorable. The existence of insanitary slums and one-roomed houses in towns like London, Manchester, and Glasgow is a disgrace to any country. The famous American preacher, Mr. D. L. Moody, once said: 'You in Britain stand more in need of homes than of churches.'

Though the local authorities make out a total of only 180,000 houses in England and Wales as being unfit for habitation, Dr. Addison[12] truly says that the real number of bad and unhealthy houses greatly exceed this total. Slums are nurseries of disease, and it is impossible to estimate the physical and moral evils of slum and tenement life which is the unfortunate lot of many thousands of our fellow human beings. Therefore the building of sanitary cottages and houses for the working-classes and those of small means should be the chief concern of both the municipal and national authorities.

Why should fair England be made hideous with rows of

* That the growth and nutrition of children are affected by the size of their homes was investigated by the School Board for Glasgow during 1905-06, who report that: 'The one-roomed child, whether boy or girl, is always, on the average, distinctly smaller and lighter than the two-roomed, and the two-roomed than the three-roomed, and the three-roomed than the four-roomed. . . . If we take all the children of ages from five to eighteen, we find that the average weight of the one-roomed boy is 52·6 pounds; of the two-roomed, 56·1 pounds; of the three-roomed, 60·6 pounds; of the four-roomed and over, 64·3 pounds. The respective heights are 46·6 inches, 48·1 inches, 50·0 inches, and 51·3 inches. For girls, the corresponding figures are: Weight, 51·5 pounds, 54·8 pounds, 59·4 pounds, 65·5 pounds. The heights are 46·3 inches, 47·8 inches, 49·6 inches, 51·6 inches.'

monotonous and mean streets, jerry-built houses, and ugly factories? Why should not our dwellings and our places of business be surrounded with ample open-air space and gardens, with free admission of fresh air and sunlight? Why should not even the humblest cottage be built with taste and comfort? Why should not our suburbs and streets be planned artistically, with a view to colour and warmth, beauty and delight, so that the whole perspective of a city or a village be in harmony with Nature, and give a pleasing appearance, and an air of repose and peacefulness? If men and women are to grow physically and morally strong, and derive pleasure and inspiration from their environment, they must have healthy homes and æsthetic surroundings.*

The disintegration of home life is one of the greatest evils that threaten the moral bulwark of civilized countries at the present day. No race or nation can be reared without a home and all the sweet and sacred influences which go to build up a healthy manhood and womanhood. As Lord Rosebery once said, 'In rookeries and slums an imperial race

* That the general health and physique of the people, especially that of the children, are affected by improved housing conditions, with provision for fresh air, sunlight, and open space, is seen by the following figures:

Town or District.	Death-rate.	Infantile Mortality-rate per 1,000 Births.
Letchworth (Garden City)	4·8	38·4
Bournville (Cadbury's)	7·5	80·2
Port Sunlight (Lever's)	8·0	65·4
Bethnal Green	19·1	155·0
Shoreditch	20·6	163·0
Wolverhampton	14·8	140·0
Middlesbrough	20·3	169·0
Average for twenty-six large towns ...	15·9	145·0

The comparative statistics as to chest measurement, height, and weight of children in Garden City, etc., and in ordinary communities are even more striking. At twelve years of age a boy at Bournville weighs 8 pounds more than a boy of the same class in Birmingham and 2 inches taller. At Port Sunlight a boy of fourteen weighs 30 pounds more and 6 inches taller than a boy of the same class and age in Liverpool, six miles away (*Modern Medicine*, July, 1919).

cannot be raised.' Homelessness is the result of the conditions of poverty on the one hand, the love of luxury and impatience of restraint and responsibility on the other. Around the family life gathers the moral and religious ideals which give stability and strength to the youth and the maiden in the long strenuous years of their after-lives. When the family and spiritual life decays, the race indeed degenerates.

In Conclusion.—The scope of this volume will not permit us to go more minutely into the subject. It is only by attacking the whole cycle of social evils in some such collective programme as indicated here that we shall be able to solve the problems of tuberculosis. We may not be able to eradicate tuberculosis altogether in this generation or the next, but we shall at least lay a sound foundation for the well-being of the people by a combined social reform, so that the disease may be driven back to the farthest limit. Besides, it was leprosy and typhus yesterday, tuberculosis to-day, and probably cancer and insanity to-morrow—all have been provoked by unhealthy conditions of modern civilized life. By going to the root of reform, we shall not only successfully deal with the disease that is most prevalent in the generation, but we shall be prepared to meet any contingency, and make it easier for the next generation to grapple with the problems that may then arise. It must not be forgotten that there has been an awakening of public conscience in regard to social duties. Some legislative reforms have already been attempted, and some happy results have been achieved by the united efforts of the community and by public health and other measures (see pp. 337 and 338).

But a great deal more is required to be done. The preventive measures of tuberculosis are largely economic and political. To put it in a nut-shell, health is the birthright of every man, woman, and child. Nutrition depends upon employment and fair wages and sufficient accommodation. These open up social and labour questions which in turn involve national and international politics. The medical profession as well as social reformers should not shrink or

stop midway, but have the courage to go the whole length and interest themselves in social and political questions so as to remedy the social evils which lead to tuberculosis.

But one may ask, Who is sufficient unto these things? Is it possible in these days to find that wisdom, strength, and enthusiasm necessary to carry out any sweeping reforms? To reorganize society, to rebuild our social and industrial life, would require an altruism which the present generation may not possess. If labour would show more wisdom and intelligence, and the *intelligenzia* (religion, science, and medicine) more soul and responsibility, they would together save the country from the present chaotic conditions and help to bring near the golden days of national health, peace, and prosperity. But one finds that the more a nation advances in civilization, the greater is the tendency for high ideals and high purpose to lose their power in influencing men's lives. Besides, democracy seems to be the last phase of almost every civilization. When it falls, as the apple from the tree, will the end come?

REFERENCES.

[1] Birmingham, *Tubercle*, June, 1920, p. 442.

[2] Framingham, *Tubercle*, September, 1921, p. 565.

[3] From the Manifesto of the International Board of the Women's International League at Geneva.

[4] 'Some Findings in Regard to the Economic Costs of Tuberculosis,' by Jessamine S. Whitney, *Journal of Outdoor Life*, July, 1920.

[5] Latham and Garland, Conquest of Consumption.

[6] President Harding, On Invitation to Washington Disarmament Conference.

[7] Powell, 'Lecture on the Prevention of Consumption,' *Journal of the Sanitary Institute*, August, 1904, vol. xxv., part ii., p. 353.

[8] Beevor, 'Descriptive Catalogue,' *British Congress on Tuberculosis*, 1901, p. 158.

[9] Kurella, Questions of To-day and To-morrow, by Sir Alfred Mond, p. 64.

[10] Baskett, *British Medical Journal*, January 10, 1920, p. 42.

[11] Mond, same as reference [9], p. 73.

[12] Addison, 'What Slums cost in Terms of Cash,' in the *Manchester Guardian*, July 30, 1921.

CHAPTER XXIV

TUBERCULOSIS IN RELATION TO MARRIAGE AND PARENTHOOD

'Chivalry, honour, and love devoted to the service of others tend to produce a transformation of instincts and a living harmony of the soul which can permanently keep open the sluice-gates of power.'—ARTHUR HADFIELD.

'For love will still be lord of all.'
SCOTT : *Lay of the Last Minstrel.*

SINCE tuberculosis is very prevalent among young people of marriageable age, the advice of the physician is often sought concerning their engagement, marriage, and parenthood. Is there any risk in getting engaged to a consumptive? Should a tuberculous person marry and have children? Would the children born of tuberculous parents contract tuberculosis? What course should be adopted if a tuberculous mother finds herself pregnant? As the whole future and happiness of young patients depends upon the right course they take, it is natural they should be anxious to have these questions satisfactorily answered.

General Considerations.—Unfortunately the literature on the subject is full of contradictions, the medical authorities being divided among themselves in their opinions and experience. One school is inclined to be pessimistic and looks upon marriage of tuberculous persons as an unmixed evil, and recommends prevention of conception and early abortion in every pregnancy, while another school with a wider knowledge on the subject is more optimistic and does not look unfavourably in every case of marriage and motherhood.

The reasons for such opposite views are not far to seek. (*a*) The records concerning the subject in question have not been carefully studied or intelligently handled, and patients

have not been kept under long observation both during and after pregnancy. Sweeping generalizations have been made from slender evidence and small statistics. (*b*) Tuberculosis has been considered as a specific entity exerting an unfavourable influence on the married state, and any relapse in the child-bearing period is put down to the extra physical strain induced by pregnancy, child-birth, and lactation in a tuberculous subject. Whereas we are beginning to see that tuberculosis is very much associated with lowered resistance, brought on by poor nutrition and bad environment, and that the effects of the disease on marriage and pregnancy are more social, economic, and psychological than specific or even physiological. (*c*) The open-air treatment has greatly modified the course of the disease, and brought a ray of hope to many a married patient who had been successfully treated in a sanatorium. (*d*) The relation of the sympathetic and endocrine glands with sexual functions from puberty onwards opens a wide field for thought, and shows that the normal activity of reproductive life is necessary both for the healthy functioning of the endocrine system and the health of the organism generally, so that tuberculosis may not be so injurious to married life as the old pessimistic school has regarded it. (*e*) Beyond the relation of the sympathetic, and the endocrine system with the sexual energies, engagement, marriage, and motherhood bring into close touch such deep emotional factors as love of the betrothed, of husband and wife, love of home and family life, love of children—all of which open up forces and 'sluice-gates of power,' which could be utilized by the consumptive in the arrest of the disease. Man's life is not determined by pathology so much as by psychology and other forces in the higher plane. The whole trend of this volume is to lift the subject of tuberculosis and all its associations from the viewpoint of microbe and metabolism, and to set it in the right perspective of human life with its complex relations, interests, and activities.

Returning to the subject, we think that the whole question of marriage and motherhood centres round two important

considerations: the patients' resisting powers and the condition of their lungs, and, secondly, their economic resources and position in life. If they are in an early stage and in comfortable circumstances and can get quite well by open-air treatment, their tuberculous condition need not make much difference to their engagement, marriage, or having children, provided they wait for a year or so before marriage, and take care of themselves afterwards, and do not abuse their married life by any kind of excess. If the disease is moderately advanced, here again the prognosis very much rests upon the patient's resisting power and his financial means which will enable him to be under treatment without anxiety till he gets well more or less completely. In cases where the lungs are badly affected and the economic and vital resources are poor, we can make a general statement that all those with acute or advanced disease ought not to marry or have children. All this advice applies equally to a tuberculous woman, only in her case the strain of pregnancy, child-birth, and lactation may act as an additional handicap. Here again, if her resisting power is greater than any physiological strain imposed by her sex, and her social and economic position ensure her living a healthy open-air life without worry or anxiety, the prognosis of her married state need not be so bad as the old school has made out. Also Nature may come to her aid by declining her fertility. This may be contrary to the views generally held, but have we unmistakable evidence to prove that tuberculous mothers are extremely fertile? If Perrin's[1] conclusions are right, then tuberculosis must be reckoned as a factor in the diminution of the number of pregnancies, and the offspring of the tuberculous are not only less numerous, but the mortality is greater among them than among the non-tuberculous. Further, Lasbennes,[2] classifying the tuberculosis mortality at Madrid since 1900, has shown that up to the age of twenty the female death-rate keeps about the same as the male or surpasses it. From ten to nineteen the proportional percentage was: Males: 41·26, 40·91, 38·22, 47·42, and 41·24; corresponding figures for females being

58·74, 50·09, 61·78, 52·58, and 58·76. After twenty the male death-rate ranged from 50·54 to 70·41 and averaged over 60, while the female death-rate ranged from 29·59 to 49·46 as the extreme figures. His inferences is that the death-rate of tuberculosis in women during the child-bearing age is less than that of girls below twenty and males after twenty. His figures find a remarkable corroboration with those of tuberculosis mortality in England and Wales as seen below:

ENGLAND AND WALES: MORTALITY FROM PHTHISIS PER MILLION POPULATION IN 1912-1914.[3]

Ages.	Males.	Females.	Ages.	Males.	Females.
0 to 5	339	290	20 to 25	1,319	1,184
5 to 10	142	191	25 to 35	1,639	1,255
10 to 15	191	420	35 to 45	2,195	1,290
15 to 20	724	1,002	45 to 55	2,305	1,104
	1,396	1,903		7,368	4,833

These statistical studies taken from both countries throw quite a new light on the subject in question and strongly suggest that: (*a*) Women are more susceptible to tuberculosis than males before they attain puberty than after twenty. (*b*) The influence of the sexual functions in women seems to exert a defence against tuberculosis, as Lasbennes observed. (*c*) Married life, therefore, may be rather an advantage than otherwise, at least in some tuberculous women. This may explain why in some cases tuberculous patients have been noticed to do well after marriage. (*d*) Child-birth may not be the sole disturbing factor in those cases of tuberculosis, which get steadily worse during that time. We have not made any discrimination between the physiological strain imposed by pregnancy and child-birth and the social and economic stress which is accompanied by worry and anxiety, especially among the working-classes. All these various considerations enable us to approach the subject of tuberculosis and the married state with a more optimistic spirit than has hitherto been done.

Engagement.—Those who are engaged need not break off their engagement with tuberculous persons on account of the disease unless they are suffering from an advanced stage. The very engagement may act as a healthy stimulus and give strength and will power to do everything necessary to get well. We have known engaged couples who, when the disease was arrested after a course of sanatorium treatment, got happily married. It is best to wait for a year or so to see what progress the patient makes, when the right course to take will become evident. It is advisable that consumptive patients who are engaged should go in for open-air treatment, as it offers a splendid prospect of recovery, especially in the early stage.

Marriage.—Should a consumptive marry? The answer depends upon many factors, some of which we shall discuss here.

First it depends upon the condition of the patient. If the disease has been in a latent or quiescent stage and the patient is more or less free from physical signs and symptoms, the fact of his having had tuberculosis need not debar him from marrying or having children. In other cases the general statement that has already been made may be repeated here —viz., that it is not advisable to marry as long as the disease is in active or advanced stage and the patient's resisting powers are poor. It was a safe rule that stood by consulting physicians to advise the engaged parties to wait for two years after all the symptoms of active mischief in the lungs had ceased before they married. This rule, good as it is, may not be applicable to every case. There is the human and psychic as well as the scientific and professional side to the question. Two cases that were recently examined by the writer will illustrate what we mean. Both of them were women patients who were treated in our sanatorium for lung trouble on the left side, and both left with the disease partially arrested, and both married within a year. Both were unhappy at home, where they could not carry out the open-air treatment satisfactorily. But marriage brought happiness, comfort, restful surroundings, and good homes, which enabled them to pursue

the treatment without worry or anxiety, and on examination it was found they were no worse for their marriage.

So that, secondly, the question of marriage depends upon the economic position of the patient. Here we have to record the case of another patient, a bachelor who got married when the disease was not in a quiescent stage, but who was nursed back to health by a devoted wife who had ample means which enabled the patient to command fresh air, good food, and other necessaries of life with which he was unable to provide himself while living in poor lodgings. So that married life in these cases is conducive to health, happiness, and contentment, which enables the patients to overcome the disease better than when they are left alone to struggle with poor food and uncongenial surroundings. In fact, financial resources affect the question of marriage considerably, as they provide the patient with the means to carry out the open-air treatment as long as necessary and get back health without worry or anxiety. This is why marriage and pregnancy and child-birth are serious problems among the tuberculous members of the working-classes and people of small means who have hard lives, poor homes, and bad surroundings which keep them in constant anxiety, drain their vital powers, and ill fit them for the duties of married life.

Again, the healthy activity of endocrine organs may influence for good the married life of tuberculous persons. Marriage and pregnancy have a favourable effect upon thyroid insufficiency.[4] Arbuthnot Lane[5] advises marriage in the case of young persons suffering from intestinal stasis with consequent toxæmia. As we have already seen, the observations of Lasbennes and the study of tuberculosis mortality in England and Wales seem to point out that the healthy activity of sexual functions in the married state would help to counteract the ill-effects of tuberculosis in pregnancy. Even the hard and practical men in insurance companies have recognized that the expectation of life of married men is better than that of the unmarried.[6]

Above all, marriage stirs up all the tender emotions of sympathy, affection and love, joy and happiness, gives the

patient an object in life and something to live for—all of which tend to open up the vital reserves and energies which make for health. Love is a dynamic force which enriches life and uplifts man in every trial and emergency. We move in a narrow circle and advise our patients in the spirit of expediency and utilitarianism. If through the influence of great fear weak and timid women have been known to run great distances, cross almost insurmountable barriers, and do heroic things, will the power of love be less potent and wonderful? If we have only faith and courage to accept the challenge which a disease like tuberculosis throws out to our patients, we shall find that every danger and disease brings its own vital energy and power, and that "as thy days, so shall thy strength be." So the question of marriage in relation to tuberculosis depends upon many factors—economic, moral, and psychological—and while the general law we have laid down holds good, no hard and fast rule can be made to apply to every patient, and each case must be judged on its own merits.

Tuberculosis and Pregnancy.—Should a married tuberculous woman become pregnant? Does pregnancy exercise an injurious influence in tuberculosis? If so, what is the cause? Does an induction of abortion afford any real help in favourably influencing the course of the disease? Medical authorities are divided in their views concerning these questions. Even those who give their consent to the marriage of their tuberculous patients advocate measures of prevention of conception, early abortion should the patient become pregnant and sterilization. The answer to the above questions very much depends, as in marriage, upon the condition of the lungs and the economic position of the patient. Patients with latent or arrested disease and practically no physical signs or symptoms need have no fear about the harmful effects of pregnancy, especially if they are in easy circumstances and can afford to maintain their health by living the open-air life. Professor Winter,[7] of the Gynæcological Hospital in Königsberg, comes to the conclusion that in most cases latent tuberculosis is not affected by pregnancy, labour, and the

puerperium, and is not an indication for interrupting pregnancy. Professor Forssner,[8] of Stockholm, who speaks from great experience, gives the analysis of 133 cases from his dispensary records of tuberculous women whom he has kept under observation before and at least a year after their pregnancy:

	Number.	Disease Stationary.	Disease Progressive.	Died.
Stage 1	71	55=77 per cent.	6= 8·6 per cent.	10=14·4 per cent.
Stage 2	40	25=62·5 " "	5=12·5 " "	10=25 " "
Stage 3	22	9=41 " "	—	13=59 " "
Total	133	89=67 " "	11= 8 " "	33=25 " "

These figures show that at least a year's observation after confinement the disease was unaffected by pregnancy in 77 per cent. in the first stage, 62·5 in the second, and 41 per cent. in the third stage. Forssner finds that a readjustment of the figures, so as to distinguish between the cases of latent and manifest pulmonary disease, also failed to show that the prognosis was worse for the pregnant than for the non-pregnant patients. He further observes that motherhood implies more work and other economic handicaps for the consumptive woman of the working-classes, and that in a large series of cases the proportion of women, whose disease has become worse, or has terminated fatally in connection with pregnancy, is practically the same as for non-pregnant controls. Professor Krause,[9] of Berlin, also observes that tuberculosis exerts no regular unfavourable influence on pregnancy, and that in a much larger proportion of cases than the pessimistic literature of the subject would lead the practitioner to believe, pregnancy and parturition is well or moderately well borne. If the prognosis for the pregnant and non-pregnant woman is practically the same, as Forssner says, the physiological strain of pregnancy must be a negligible factor, and any injurious influence which pregnancy may exert in the course of the disease must be due to

extra work and mental strain entailed by the bad economic and hygienic environment of the patient. This failure to distinguish between the physiological handicap which pregnancy may involve from sociological and psychological factors, such as poor food, unhealthy environment, extra stress and anxiety, etc., may be the chief reason for writers like Fishberg, Pankow, Küpferle, Winter, etc., to take a pessimistic view of the effects of pregnancy and child-birth in tuberculosis.

Tuberculosis and Induction of Abortion.—The practice of induction of abortion on account of tuberculosis differs among different medical men and in different countries. The Italian doctors recommend induction in every case of tuberculosis.[10] In Germany Bumm[11] advises abortion when the disease is aggravated during pregnancy, and Winter[12] when the disease is progressive, when there is high temperature, rapid loss of weight, bad family history, and in laryngeal tuberculosis. In America Fishberg, and Norris and Landis,[13] justify prevention of conception and abortion before the fifth month. In Sweden the beneficial effects of abortion are doubted. Krause[14] says that even in manifest pulmonary tuberculosis, abortion should not be induced as a merely preventive measure against a possible or probable retrogression of the disease, and should be undertaken when there are clear signs of activity and continued progression of the disease over a period of two or three weeks. The only way to test the beneficial effects or otherwise of abortion is to compare the results of interrupted with uninterrupted cases of pregnancy. Pankow and Küpferle induced abortion in 100 cases, while Forssner allowed 82 of his cases to go to full term, with the result as shown in table on next page.[15]

These figures go to show that the results are better when pregnancy was not interrupted than when it was, and that Pankow and Küpferle's claim that abortion benefited their patients is not confirmed. Forssner,[16] after weighing all the evidence, comes to the conclusion that there is at present no reliable evidence to show that the interruption of pregnancy, either by simple abortion or by more extensive operations,

can favourably influence the course of active pulmonary tuberculosis. Our own experience is that while abortion is not necessary in quiescent or early cases, in acute disease it did not save the patient's life.

	Pankow and Küpferle.		Forssner.	
	Stationary or Improved.	Worse or Died.	Stationary or Improved.	Worse or Died.
Stage 1 Stage 2 Stage 3	62 = 85% 6 = 35% 1 = 10%	11 = 15% 11 = 65% 9 = 90%	34 = 87% 21 = 70% 8 = 61%	5 = 13% 9 = 30% 5 = 39%
Total ...	69 = 69%	31 = 31%	63 = 77%	19 = 23%

Tuberculosis, Pregnancy, and Sanatorium Treatment.— Recent writers have observed the beneficial influence of the open-air treatment in the tuberculous mothers, and in the children born after the sanatorium treatment. Schäffer[17] not only points out the importance of sanatorium treatment during pregnancy, but notes the great proportion of survivals among the women who had become pregnant after sanatorium treatment as compared with the patients who had not become pregnant. Our experience also is that a sanatorium offers a bright outlook to tuberculous fathers and mothers and their children born after the treatment. To give a few instances:

(*a*) Mrs. H. and Mrs. L. both came to the sanatorium in 1920, and remained during the first six months of their pregnancy. Both somewhat early cases. Their first children were born in January, 1921. Up to the present (eleven months after) both mothers and children doing well.

(*b*) Mr. H., in the sanatorium in 1918. A child was born in 1919. Both father and child doing well.

(*c*) Mr. W., in the sanatorium in 1911. His fiancée also tuberculous and had open-air treatment. Married, and child born in 1916. Both parents doing well. The child is very strong and healthy. See Fig. 27.

FIG. 27.—CHILD BORN AFTER SANATORIUM TREATMENT.

To face page 362.

FIG. 28.—CHILDREN BORN AFTER SANATORIUM TREATMENT.

To face page 363.

(*d*) Mr. H., in the sanatorium in 1910. Married, and child born in 1912. Both father and child doing well.

(*e*) Miss V. (now Mrs. M.), in the sanatorium in 1902. Married, and has two fine boys, aged fourteen and seventeen. Both mother and children have kept well. See Fig. 28.

In the first instance (*a*) both the patients were advised to undertake sanatorium treatment during the first six months of their pregnancy. Both have kept well, and on examination six months after the children were born there were no signs of a return of the disease. These two cases show that sanatorium treatment during the early months of pregnancy, especially in the early stage, would save many a tuberculous mother and child. Reviewing the whole subject, we may conclude: The researches of Perrin, Lasbennes, Forssner, etc., the mortality figures of tuberculosis and other facts presented in this chapter seem to overthrow the pessimistic views of the older writers concerning marriage, pregnancy, and child-birth. The advantages of artificial abortion have been rather exaggerated. In early cases it is not necessary, and in advanced cases it is doubtful if it holds out a better hope of saving the patient's life. Where it is undertaken it should be induced before the sixteenth week. Since open-air treatment is found to have a beneficial effect on the tuberculous mother and the unborn child, it should be tried during the first few months of pregnancy. There is no evidence of direct transmission of tuberculosis from the parent to offspring. As has already been shown, heredity from a persistent vicious (economic and hygienic, etc.) environment can cause a weakness of constitution and lowered vitality which can be more or less successfully overcome by good environment in a generation or so.

Lastly.—What advice should be given to our married patients in the convalescent stage of tuberculosis? Three courses are open: Abstinence, prevention of conception, or leaving them to take a natural course. We feel we are not justified in advocating the neo-malthusian doctrine to our ex-patients as some have done. While self-restraint is in many ways better than self-indulgence, both extremes are

unnatural. Our duty is to advise the patients to do everything in their power to get well, and keep well, and then let them follow the natural course. The figures and facts brought forward in this chapter do not support the argument adduced in favour of prevention. They go to show that marriage may be a defence rather than a drawback in tuberculosis. Besides, prevention is a clumsy weapon by which the organism may lose more than it may gain. Violation of Nature's laws will sooner or later inevitably bring physical and moral injury to the organism. On the other hand, Nature will not betray her followers if they are true to her. While she is lavish in her gifts she will not give help to those who will not make use of them. Wrap up your talent and bury it, you will lose what you already possess; but fling it wisely, you will gain more than you lose. Love, children, home are the greatest living forces in the world. They keep the heart young, and life fragrant by their presence. We have known a chronic consumptive who worked for twenty years to keep his wife and family from starvation. We know of another case, of a drunken, work-shy consumptive who took a fancy to a foundling, and while pouring out his affection and tending and caring for the child, he found the salvation of his own health. So love and devotion in the service of others open up fountains of power and strength which go towards the cure of the body. The civilized man has been living an unnatural life. The teaching of the open-air treatment is to lead him back to the open country and to natural life, when many of the present difficulties which threaten the married state will disappear. When every man has work to do, and every home a garden of delight, tuberculosis will become a thing of the past, and there will be no need to pry into the garden of Eden. For women will be proud of their marriage and motherhood, and every child born will be a welcome guest. Meanwhile, worldly prudence and expediency may think them a folly in tuberculous persons. But love will give the consumptive courage, endurance, and wisdom to act rightly in every human relation, and will rather sacrifice itself in the cause of its dear ones than bring

suffering to them. For it knows that the corn of wheat falls to the ground and perishes only to live again, and death is swallowed up in a larger life and victory.

REFERENCES.

[1] Perrin, *Paris Médicale*, February 28, 1920, and *Tubercle*, July, 1920, p. 473.

[2] Lasbennes, *American Review of Tuberculosis*, vol. iv., 1920-21, Abstracts, p. 14.

[3] Eighty-first Annual Report of the Registrar-General of Births, Deaths, and Marriages in England and Wales (1918), p. lxx.

[4] *The Practitioner*, January, 1915, p. 66. [5] *Ibid.*

[6] Bardswell, Advice to Consumptives, p. 96.

[7] Winter, *Tubercle*, August, 1920, p. 514.

[8] Forssner, *Ibid.*, p. 510.

[9] Krause, *Tubercle*, November, 1919, p. 60.

[10] *Ibid.*, p. 70. [11] *Ibid.*

[12] Same as Reference [7].

[13] Norris and Landis, *Tubercle*, November, 1919, pp. 69 and 70.

[14] Krause, *ibid.*, p. 62.

[15] *Tubercle*, August, 1920, p. 512.

[16] Forssner, *ibid.*

[17] Schäffer, *ibid.*, p. 517.

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